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PRINCIPLES OF ELECTROLYSIS

Methods of Measuring and Preventing Corrosion of Pipes and Cables along a Railway System

BY C. PAGANO.

The phenomena accompanying the electrolysis in a railway system, which uses the rails for the return current, are very interesting and of great importance because of the deleterious influence which electrolysis has on the neighboring pipes and cables lying underground.

The simple principle of electrolysis is that if a current is conveyed through a liquid from one metal to another, which constitute the electrodes of the system, metal will be deposited on the negative pole, while the positive pole will be dissolved, becoming oxidized from the action of the oxygen collecting at that point.

The fall of potential, due to ohmic resistance, along the rails will cause differences in potential in different points of the rails, and since earth is a poor conductor, a current will be produced, which will leave the rails at the points of generation and reach them in a part nearest to the power house, but this transmission through the earth will be effected at the expense of the chemical decomposition of the different saline elements residing in it, hence the oxygen will be brought to the positive pole corroding the rail at the point of exit. This corrosion on a great surface is not a source of danger, nor does it carry much weight in economical consideration, especially if the rails are made of good high quality steel, as a current of one ampere will corrode only 20 pounds of iron in a year. But deleterious effects, for which provision must be made, will appear in the neighboring pipes or lead-sheathed cables which lie underground.

The current leaving the rail will prefer the nearest metallic conductor, and in cases of great intensity, corrosion will take place where the current leaves the conductor to enter the rail again near the power house. This, in the case of lead cables, will be a serious matter when it is understood that lead is eaten away at the rate of 14.34 pounds per year with a current of one ampere.

The trolley, as generally used, is connected to the positive brush of the generator, because in that case the areas of corrosion will be comparatively smaller and nearer the power house; whereas, if the trolley were connected to the negative-brush, the current would flow out from the rail and corrosion would be spread over a very large area, and hence less susceptible to repairs and inspection.

The corrosion, however, of pipes and cables is not entirely due to electrolysis, but often to chemical action of the salts lying in the earth, and it is sometimes useful to ascertain the value of each in order to decide what provision to make to diminish the corroding effects due to both causes. In this connection it is safe and simple to use the method proposed by A. B. Herrich, which is "Have half-round best shields made of the same material as the pipe under experiment, with the inside diameter corresponding to the external diameter of the pipe and the length three or four times the diameter; uncover the pipe for a length of 6 or 10 feet, carefully clean and amalgamate a length of it corresponding to the length of the shields, the inside parts of which must have the same treatment. Tighten two of these shields firmly with bolts passing through opposite flanges; another pair, not amalgamated, are fastened in the same way some distance from the first, but insulated by a sheet of rubber from the pipe. The first pair are thus in good metallic contact with the pipe while the second pair is insulated from it. Cover the whole length with earth and leave it undisturbed for 6 months, after which take off the shields, clean and examine them carefully and compare the actual weight with the weight taken before they were put in operation. If the insulated shields are corroded, it is caused by chemical action while the corrosion in the non-insulated pair could be due to both electrolysis and chemical action; hence the difference between the two effects will determine the result of the two actions."

The difference of potential between the pipe and the rail depends upon the current flow between the two and on the resistance of the earth. The potential required to generate electrolysis exist between the pipe and the earth and can be very small, while that between the rail and the pipe may be quite high on account of the resistance of the intervening earth. To have electrolytic action on a pipe, this should be positive to the earth; so if a test proves that the earth is posi-

tive, there will be no danger of corrosion at that point.

A good reliable method to ascertain the difference of potential between a pipe and the earth is proposed by the same Mr. Herrick and consists of two insulated rods driven in the ground, one touching the pipe in experiment and the other through the earth, but at the same level as shown in Fig. 1. An external circuit consisting of a galvonometer, a standard battery, two switches and a slide resistance with an indicating scale is connected to the two rods. When the resistance is adjusted so that the galvonometer indicates zero current, then the difference of potential between the pipe and the earth will

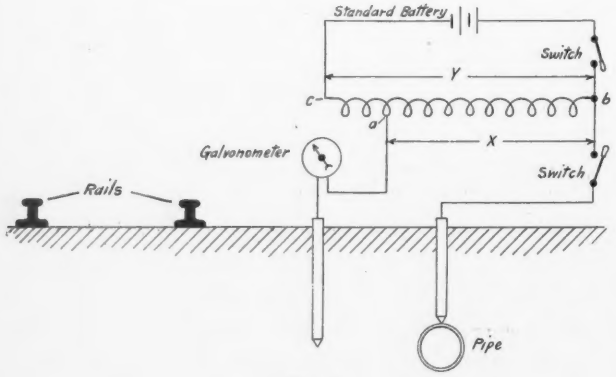


Fig 1

bear the same relation to that of the standard battery, as the resistance x between a and b bears to the total resistance y between c and b and the total electro-motive force between the pipe and the earth will be

$$E_1 = Ex \div y$$

in which E is the electro-motive force of the battery and x and y the two resistances of the slide resistance as shown by the readings ab and cb.

As the indicating scale on the sliding resistance gives the ratio of resistance instead of the value in ohms, x and y may be taken as the parts on the scale. For instance, suppose E equals 5 volts and the sliding scale is divided into 100 parts and when the galvonometer reads zero, the contact is at 25, then $E = 5 \times 25 \div 100 = 1.25$ volts.

To measure the intensity of the current in a pipe, clamp two terminals firmly to the pipe, 5 or 6 feet apart, and connect through low resistance connections an ammeter A with a switch S and a milli-voltmeter V across the two terminals as shown in Fig. 2. Readings from the milli-voltmeter are taken with switch S, open and closed, and the ammeter readings with switch S closed. The readings of V will be less when S is open, because the ammeter is out of the circuit. The current that flows through the pipe is then calculated by the following formula:

$$C = \frac{C_1 E}{E - E_1}$$

where C = current flowing through the pipe
C_1 = current indicated by A with S closed
E = voltage with S open
E_1 = voltage with S closed.

To prevent or diminish to a negligible or reasonable limit the value of the effects of the electrolysis, the trolley, as said before, must be connected to the positive side of the circuit; the track should have a large conductivity; the bonds are required to offer the least resistance possible; any metallic connection must be removed between pipes or cables and rails; return feeders should be provided to relieve the rails in case they carry an excessive current so as to prevent a great fall of potential across the path; as the greater the fall of potential in the rail, the greater is the probability of the current passing on to neighboring pipes. Pipes, cables and other metallic conductors can be protected by laying them in glazed tiles, as is commonly used and providing the return feeders for those pipes carrying a great current, so as to draw off this current directly from the pipes which prevents it from passing to the ground.

It is not adivsable, I think, to connect a low resistance wire to a pipe, when electrolysis is discovered, because a large part of the current would prefer the wire path, and if the pipe would be spared, the rail on the contrary would suffer to a great extent from the effects of electrolysis. Besides, a current will flow through the earth around the joints of the pipe, caused by the high resistance of the joints themselves, and thus the system would shift the electrolytic action from the pipe in a place near the power house, to the rails and joints in the pipe farther away and more difficult to inspect and repair.

These rules, used generally all over the world, are the best "receipt" for electrolytic action so far as the subject is understood. In France, however, a rule known as "the rule of 5 volts" is actually in use, which is as follows: "The difference of potential between two points of a city track must be less than 5 volts, and also less than 5 volts between the rails and the pipes or underground conductors in the dangerous direction." In country places, where the probabilities of underground pipes and conductors are less, a fall of potential of one volt per mile is permissible and in certain cases to the limit of 2 volts, without inconvenience. The German rules have not so much confidence in the measurements of the difference of potential between the rails and the neighboring metallic conductors,

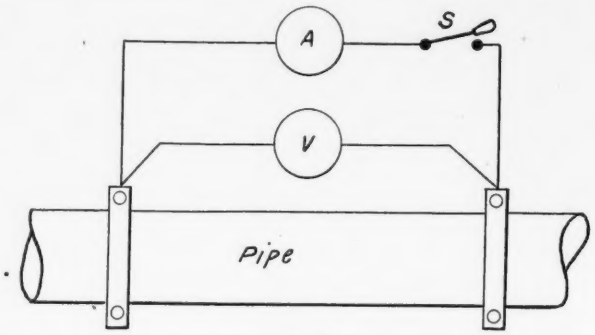


Fig. 2

but they prescribe that the difference of potential between two points of the ground in any interior place of the network of the underground conductors or pipes, as measured by the employment of two rods driven in the ground at the same level of the pipes or cables, but 5 or 6 inches from them, should not exceed 0.3 volts.

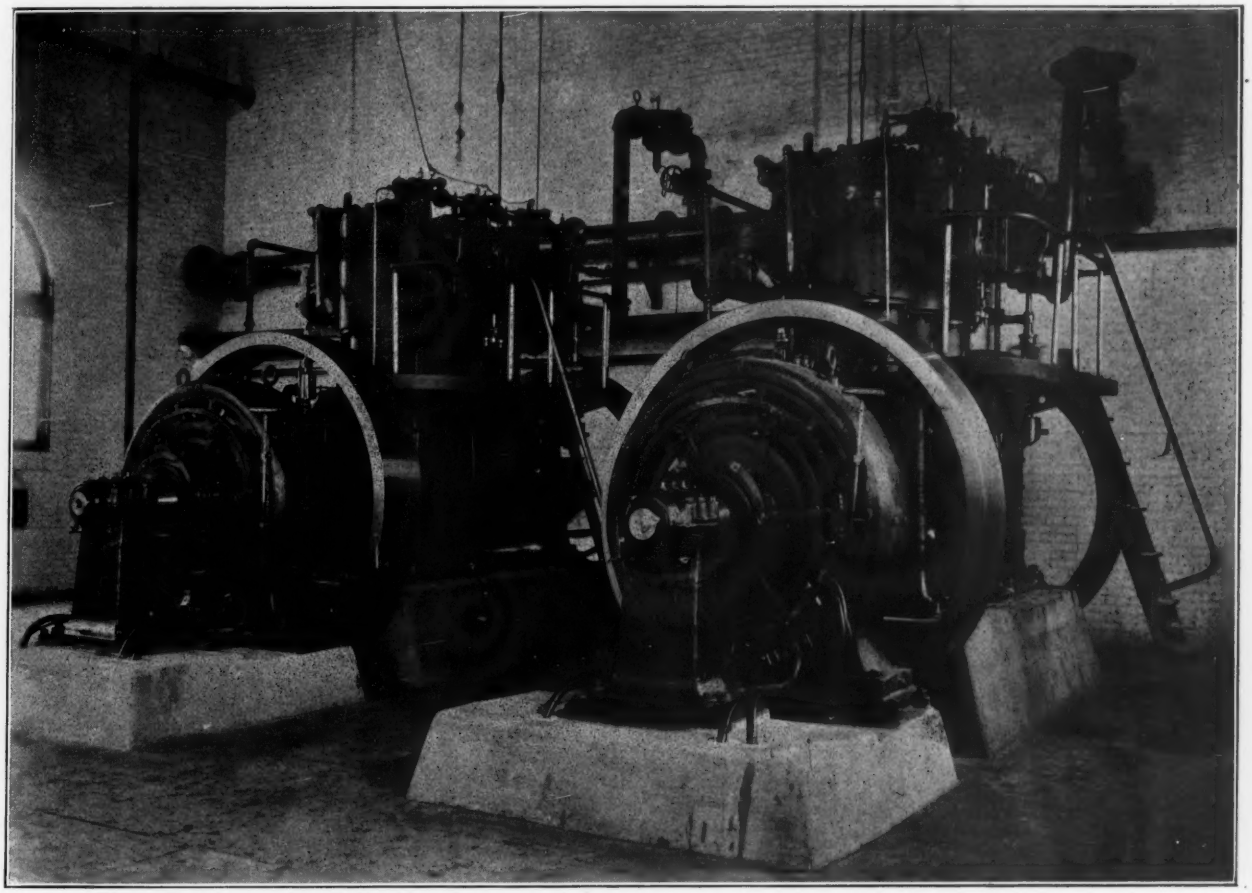
So far as I have explained this difficult subject, it can be seen that there is an argument of great importance and a field can be opened up to ulterior observations and experiments easy and interesting to the engineer connected with the railway business.

A SUCTION GAS POWER PLANT

Producer Plant of the Firth-Stirling Steel Co., near Washington, D. C.

When the Firth-Stirling Steel Company erected their plant at Giesboro Point, a few miles below Washington, D. C., the location selected was one which gave no thought to the fuel supply, as it was desired to be near the National Capital, owing to the peculiar business of the plant, which is the manufacture of ordnance for the U. S. Government. Located as it is on an isolated point on the Potomac River, the question of fuel supply, however, became an important factor after once the plant had been erected.

Owing to the necessity of uninterrupted service, a duplicate equipment of producers and engines are installed. There are two producers and two engines, each gas unit consisting of a water-sealed Westinghouse producer and wet coke scrubber, with a three-way valve between, connecting with the purge stack. The plant is designed for steam to a reserve steam engine, and for use in the mill, but under ordinary conditions of operation the boiler is not needed.



Interior of Engine Room, Firth-Stirling Producer Plant, Giesboro Point, Washington, D. C.

For the operation of the many lathes and other machinery with which the plant is equipped for turning projectiles, etc., electric motors are used and the prime movers for operating the electric generators are gas engines driven by anthracite producer gas. The fuel used in the producers is buckwheat anthracite and the floor space of the whole power house, which is built for a large increase in capacity, is 45 by 152 feet, the engine room being 64 feet long by 45 feet wide, and the producer room 84 feet long with the same width.

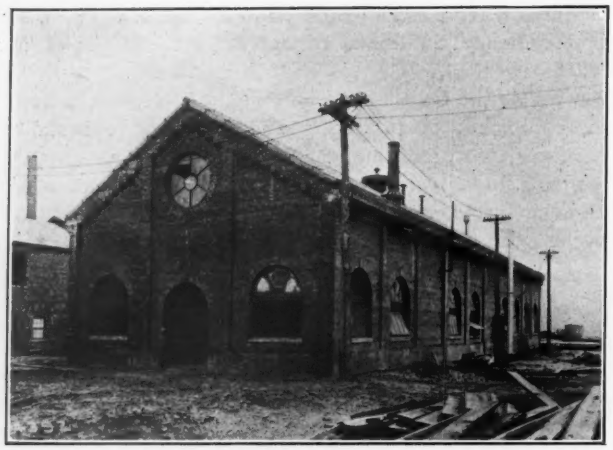
The outside view of the station shows one iron stack, due to the fact that one 150 H. P. boiler is used for supplying continuous running, and ashes are removed at intervals through the water seal without disturbing its operation.

From each scrubber, a 12-inch gas pipe leads to a common header 16 inches in diameter. This header leads to the engine room, and through a T connection to 12-inch pipe which supplies the two gas engines. Six-inch lines containing gas regulators supply each engine.

The two gas engines installed are of the three-cylinder vertical Westinghouse type, having cylinder 16″ × 18″, both being direct-connected to 110 K. W. 250-volt generators running at 350 revolutions per minute.

Coal for the power plant is brought up to the side of the

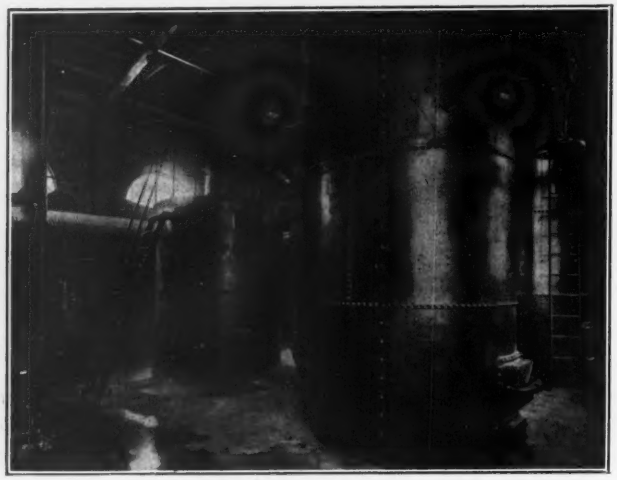
plant on a railroad siding, and is shoveled by hand into a coal storage bin on one side of the producer room. It is then elevated by a bucket conveyor to a small hopper supported on roof trusses. The hopper has a capacity of 2.4 tons, and is filled as often as the demand requires, the elevator being operated by a one-horse power motor. From the hopper the coal is fed to the producers by 10-inch riveted pipe.



Exterior of the Firth-Stirling Producer Plant

As a reserve, in cases of emergency, the plant is equipped with one 150 horse power Babcock and Wilcox boiler, equipped with a Wilkinson stoker for burning the same fuel as is used in the producers. The steam furnished by the boiler is used as a reserve for furnishing steam to the plant, and also for supplying a 14″ × 24″ × 14″ compound vertical Westinghouse engine, which is located in the engine room, and which is belted to a 150 K. W. 250-volt direct-current generator.

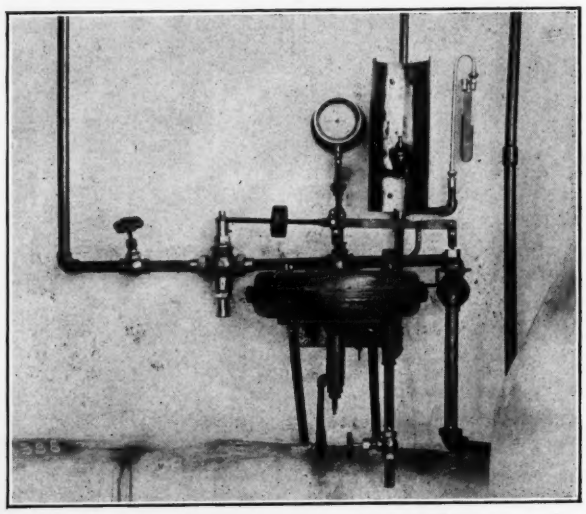
No storage capacity for gas is used in this plant, except that which is obtained in the gas main, an automatic regulator being used, which maintains the gas delivered to the engine at a uniform pressure. As employed on all Westinghouse producers, the seat of control is the pressure at the nozzle of the steam injector blower supplying air to the producer. The steam supply is varied by throttling, according to the demand for gas, through the action of the pressure regulator. The regulator is of the diaphragm type, and is connected to the main header in the engine room, which supplies gas to the engines. As the demand for gas increases, the pressure falls and the regulator opens the throttle of the blower until enough gas is made to bring the pressure back to normal. The producer blowers are located in a concrete pit covered by steel floor plates, which effectively confine the noise of the latter and yet provide ready access.



Producer Room, Firth-Stirling Plant, showing Producers and Scrubbers

The use of individual scrubbers in place of a central scrubbing plant has the advantage of permitting independent continuous running. A reserve scrubber would otherwise be necessary so that the carrying of the unit system in the gas, as well as in the engine plant, imposes no serious burdens.

The engines are direct-connected to the generators and have heavy fly-wheels between the generator and engine. Each cylinder has two valves, one inlet and the exhaust, both of which are of the poppet type, and seat vertically.



Automatic Gas Regulator Used with Producer Plants

The cylinders are water-jacketed, as are also the exhaust valves. For this purpose the valve stem is made hollow with an internal concentric tube rising to the valve head. Cold water enters through a flexible rubber hose connection, ascends through the outer space, and descends through the inner tube, which operates as a water seal.

The engines are regulated by the governor and mixing valve. The governor is of the fly-ball type, geared directly to the main shaft, and regulates the mixing valve through a direct linkage. The mixing valve performs two fundamental functions: the proper proportioning of air and gas, and the control of the quantity of mixture delivered to the cylinder. The mixing valve is of the poppet type, as that form lends itself less to the obstruction of dust and tar found in producer gas.

The engines are started with compressed air, which is admitted to one of the cylinders while the two others are supplied with gas. The air is stored in a tank in the engine room, and is compressed by an 8″ × 5″ air compressor installed in the producer room.

The gas is ignited by a make-and-break igniter, which consists of two poles, one stationary and the other movable. The movable pole is actuated from the outside by a trip, and interrupts the current at the beginning of each power stroke. The contact points are made of platinum, which resists the heat and which is said to be the best metal for standing the severe service to which they are subjected.

Owing to the brief time this plant has been in service, no data is available for obtaining the operating efficiency, but similar data has been obtained by Mr. J. R. Bibbins of the Westinghouse Company from the gas-driven lighting station at Keene. N. H., which gives some idea of the character of results obtained. The Keene plant is serving a general 24-hour lighting system, and although of only 270 kilowatt capacity, is similar in equipment to the Firth-Stirling plant. With coal at $4.60 per ton, this plant has been able to generate power for a total operating cost of approximately one cent per kilowatt hour, at 20 per cent. load factor. On an 8½ months' run, with an average load on unit of 50.9 per cent., the total coal required per kilowatt hour was 2.94 pounds, and the total coal per brake horse power was 1.86 pounds. The approximate calorific value of the coal used was 12,500 British thermal units, which gave an absolute net heat efficiency from coal pile to switchboard of 11.9 per cent.

When the kind of producer plant was being considered for this plant, the problem of selecting a type of plant which would give the cheapest gas for the fuel available and the first cost of plant were the important factors. Of the two kinds of plants, bituminous and anthracite, the relative cost of the fuels available showed that even with a more efficient bituminous plant, the anthracite producer would give cheaper gas when the cost of the low price anthracite fuel was compared with the comparaitvely high price bituminous coal, particularly since the location of the plant is some distance from the mines. At this location the cost of bituminous fuel is about 25 per cent. more than buckwheat.

The electricity produced by the electric generator is used for light, heat and power. All the buildings are lighted with electric lights and the administration building is heated throughout with electric radiators.

A TALK WITH A CHIEF ENGINEER

Practical Points in Reference to Brine Tanks, Water Filtration, Motor Ventilation and Barrel Rheostats

By William Kavanagh.

The valuable amount of information which the writer obtained from the chief engineer of a large plant in reference to boiler feeding, firing, sparking commutators, dead generators and pipe covering, which was described in the August issue of this paper, resulted in another call upon this chief at the first opportunity. This time the writer provided himself with some blank paper so as to take notes on practical points the chief might illustrate or talk about.

Having inquired at the engine room where the chief might be found, the writer was informed that the chief was in the brine-tank room, where he was found watching the men pulling out cans of ice from the brine. The chief received the writer cordially and invited him to a seat in a quiet corner of the engine room. The chief began the conversation by saying that it was necessary for him to watch the men pulling the ice, as the chief had a rule that only "every other can" should be pulled. He said that before that rule was made the men would pull every can and dump the ice in a great pile on the floor, where a large portion of it was allowed to melt. Then they would fill all the cans with fresh water, which ran the temperature of the brine up to 28 degrees and sometimes as high as 32 degrees Fahrenheit. So the chief decided to have only half the cans of ice pulled at one time. By this means he is able to supply all the demands for ice and at the same time the temperature of the brine is maintained at a lower standard.

"Another thing which I found gave me a great deal of trouble were the leaky cans," said the chief. "I noticed that the brine was always increasing in quantity and decreasing in gravity. I found that the men who pull the ice, handle the cans roughly, making them leak. Therefore I keep a supply of cans on hand, and when a can leaks another is put in its place and the leaky can repaired. The cans are filled with filtered water somewhat higher than the brine, and this extra height is sufficient to force out the fresh water into the brine, weakening it and necessitating the frequent use of salt to increase the gravity of the brine.

"The method for the making of the brine that was in use before I came here was this way: The men attending to the brine had a large can, the bottom of which was perforated with a number of small holes. This can was placed above the brine in the tank and then fitted with coarse salt. One of the men was detailed to pour brine down through the salt. The brine was thus strengthened in gravity and would

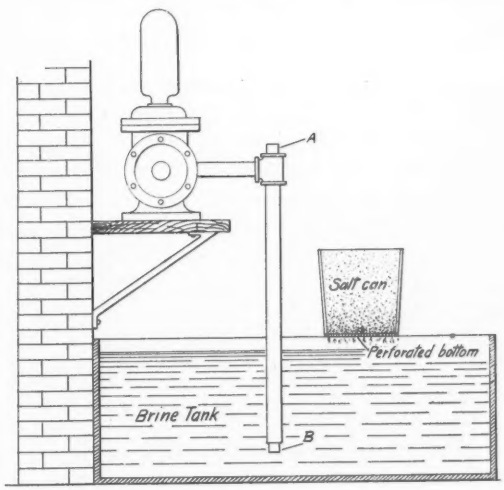


Fig. 1

flow through the perforated bottom into the brine tank." The chief then drew a sketch of the arrangement as shown in Fig. 1.

After drawing this sketch, the chief explained that it took from one to two hours for a man to dissolve the salt by pouring the brine on it. "Well," continued the chief, "when I took charge I adopted a more simple plan in the making of the brine, and it works to perfection. I select a bag or sack that is free from rents, and I fill it with salt and place it in the brine tank directly under the return brine from the refrigerating coils. The return brine is warmest and therefore the salt dissolves more rapidly than if placed at the suction end of the brine tank. There is economy in making brine this way, as no salt can leave the sack until it is dissolved; besides, no extra labor is required, as the brine circulating pump does the work.

"Speaking about the brine pump reminds me of how the erectors of the refrigerating plant connected the brine pump. They connected it about three feet above the surface of the brine tank, and if you stopped the pump for packing or cleaning out the valves, the suction was lost and I had a difficult time to get the pump to form the suction again."

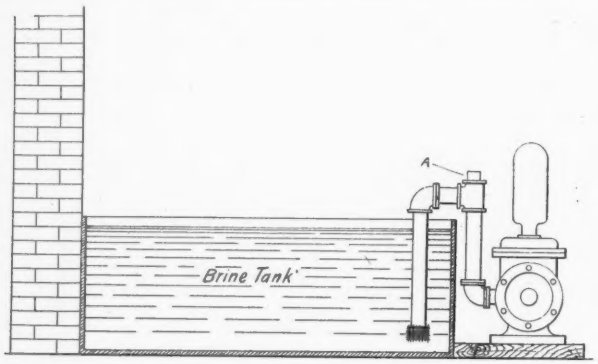


Fig. 2

The chief then reached to a closet and pulled out a large pair of gloves that cost $7.50, at the same time explaining how the gloves were used in plugging the suction of the pump. "You see," continued the chief, "once the suction is lost, you would have to remove the plug at A, Fig. 1; then after pulling on the gloves, you would have to reach down in the brine and plug the suction at B with a wooden or cork plug. After this, the suction would be filled with brine and plug A screwed in; then the pump would be started and at the same time removing plug B and running the pump faster to try and form the suction. After I took charge, I tried this plan a few times, and although every care was taken, it took from one to three hours to form the suction. Well, I knew from experience that the pump would often get out of order and choke up with dirt, so I took the pump down from the wall and connected it on the floor below the brine level." The chief then drew the sketch as shown in Fig. 2. The plug at A is removable for the purpose of charging the pump at any time, should it become necessary, and the suction pipe is fitted with a strainer which prevents any foreign matter from entering the pump chamber.

At this point the writer asked the chief how he produced such clear ice. The chief explained that he used distilled filtered water and was very particular to explain how distilled water must be filtered if clear ice is required. It is difficult to imagine how steam can carry in suspension sediment and dirt from the boiler, but the chief proved this by showing a bottle of unfiltered distilled water which he had laid in a quiet place that was free from vibration so as to permit and foreign matter held in suspension to settle down to the bottom of the bottle. In this case, the bottle was covered with a fine deposit resembling sand. "Why," said the chief, "it is this matter which is held in suspension by the steam that cuts the ports, valve-faces and cylinders of engines. If you desire clear ice you must allow the filtered water to rest, but if you don't, your ice will be discolored You have seen how the bottom of the bottle was covered with mud; well, it is only reasonable to expect that the bottom of the storage tank, in which the filtered water is stored, must contain some deposit, and for this reason I have connected the filling hose about ten inches above the bottom, which prevents any agitation of the dirt.

"To filter the water properly after it is discharged from the reboiler, it should travel through a bed of fine white sand, then a bed of charcoal and afterward through a bed of clear sponges. The sponges can be taken out and should be washed daily in filtered water, otherwise they will contain some dirt.

"The last time you were here I mentioned about the use of compressed air for cleaning motors, and since then we have adopted a ventilating system which keeps the motors cool and at the same time clean. It is a simple, inexpensive plan, and should be adopted in every motor-driven plant of any respectable size. We enclosed the motors in boxes that are as air-tight as it is practical to make them. We then connect each box with a suction pipe that is operated by a medium size fan. Of course, some air enters the boxes through the belt holes, but the fan forms a powerful suction which draws out all the heavy dust, keeping the motors practically clean." The chief drew a sketch similar to Fig. 3 and explained how the exhaust fan was connected at the end of the suction line at A, the belt holes being shown at B in each box. The sides of the boxes are made removable and all cracks are covered with rubber strips, which prevent to a considerable degree any excess of dust from entering the boxes.

Since my last visit to the plant, the chief had considerable trouble with one of the rheostats belonging to one of the small generators, and, not having any spare rheostat to connect up in place of the injured one, he was compelled to make use of the barrel rheostat. The chief then drew a sketch of the rheostat similar to Fig. 4, as it may become necessary at any time to make use of one. The copper plate A is movable, and it can be lowered or raised at will by means of the cord and weight D, the copper plate B being stationary. The chief explained that in order to decrease the resistance of the water it must be acidulated either with common table salt or sulphuric acid. "One particular point, that must be watched," the chief said, "was the wire connecting A, as any active agent used to decrease the water resistance would weaken the wires connected to the copper plate, and if you are not watchful the wire suspending the

plate A will break, causing the plant to shut down and the dynamo to be reversed. Should the dynamo be reversed, the chemical action on the plates and wires will also be reversed.

"In starting the barrel rheostat particular attention should be given to the wire that wastes away most rapidly. This wire should be made the stationary one, so that there will

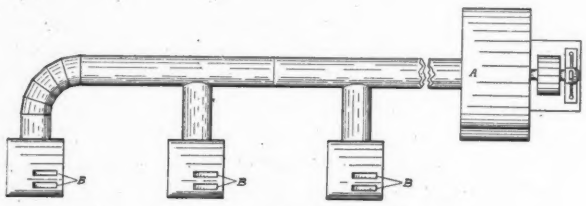


Fig. 3

be less liability of an accident occurring." The reason why the plates and wires waste away, the chief explained as follows: "Whenever the current is passing through the water and salt is used, the copper dissolves and unites with chlorine, which is liberated from the salt and forms a chloride. If sulphuric acid is used, a sulphate of copper is formed, thus weakening the wires."

The rheostat which had burned out was one of those in which the wires are buried in cement, making it almost impossible to locate the injured coil without chipping out the cement, and in doing this more harm is likely to be done than good. The chief was of the opinion that this type of rheostat should be dispensed with, owing to the difficulty of making repairs. The type of rheostat that has its coils exposed or readily accessible was the type the chief recommended. "You know," continued the chief, "all machines wear, and nowadays manufacturers of machinery actually acknowledge this fact, and in their catalogues you will find how they point out the accessibility of parts that are likely

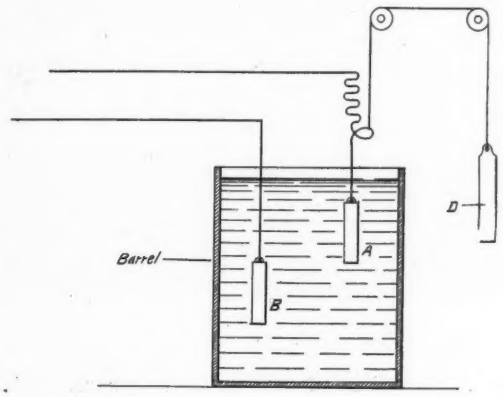


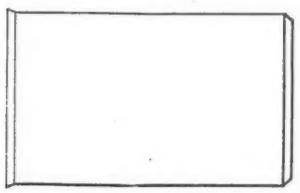
Fig. 4

to wear and the facility with which such parts can be renewed."

The writer was about to leave, but the chief wished to explain how successfully he was heating the buildings without closing the back pressure valve. The chief said: "When I took charge, as my predecessor had used a pump governor, I also used this governor, but soon found that in order to form even a poor circulation through the heating coils over six pounds back pressure would have to be carried, and in severe weather I would have to run the back pressure up to ten pounds. Of course, you are aware that the returns lead into this pump governor, and when it contains a certain amount of water the float opens the pump throttle, starting the pump so that the return water is discharged either into the boilers or sewer. Even at ten pounds back pressure, the employees were constantly grumbling about lack of heat, so in order to overcome this difficulty I connected the returns direct to the suction side of the pump and I run the pump constantly on those returns. I control the speed of the pump by means of the throttle, and in order to keep the pump cool I attached a small water connection in the return near the pump cylinder. When a small stream of water is injected into the returns, it assists the pump to form a vacuum by reason of condensation, and I can tell you for a fact the circulation is perfect and the coils are all warmed without closing the back pressure valve. I accidentally discovered that the buildings could be heated this way. One cold morning the assistant started up as usual and he forgot to close the back pressure valve. The return pump is located in the boiler room, and it is the duty of the firemen to start this pump every morning and to allow a little injection water to enter into the suction. The fireman was attentive to orders and never forgot to start this pump, so that on this particular morning he had the return pump running as usual. After taking a walk through the building and finding everything in fine order, I came down in the engine room and found the back-pressure valve open. After this discovery the back-pressure valve was never closed. For the sake of information, I connected a vacuum gauge on the pump and found that I was forming a ten-inch vacuum, which was sufficient to pull the exhaust steam through the heating coils in the most remote part of the building." The writer had to leave at this point, and thanked the chief for his valuable information and promised to call again.

Drift for Babbitted Box.

Did you ever have a "hurry-up" job babbitting a solid box and have to spend three-quarters of the time scraping



Drift for Babbitted Box

the box out for a running fit? A writer in "Machinery" says that one way to overcome this is to take a short piece of shafting, and with a light hammer upset one end so that it becomes about one-hundredth of an inch larger in diameter. File or grind the sharp corner from the other end. This makes a handy drift which can be driven through the babbitted box, expanding the babbitt tight in position and making an easy-running fit for the shaft.

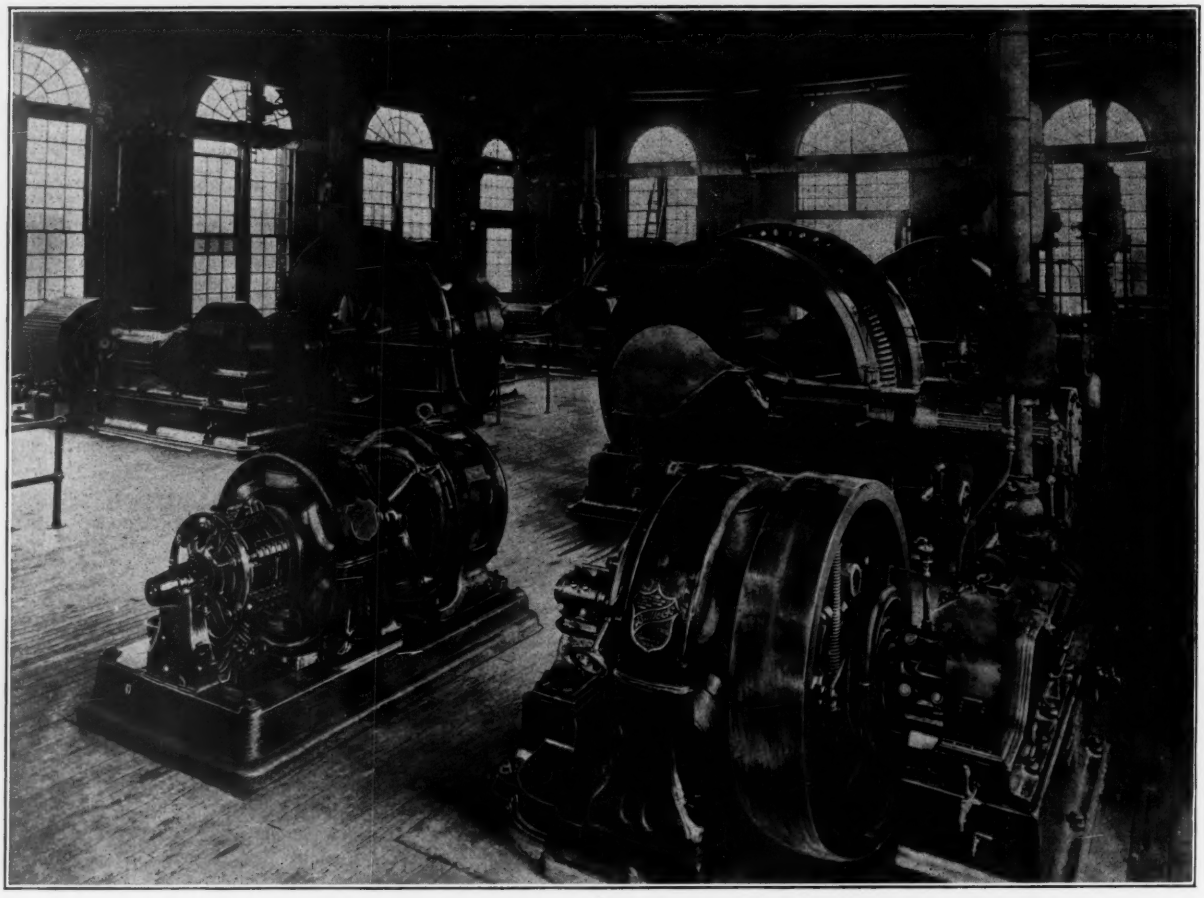
MACHINERY USED IN COAL AND COKE OPERATIONS

York Run Power Plant of the H. C. Frick Coke Co.

By W. B. Spellmire.

The total annual capacity for the production of pig iron by the United States Steel Corporation at the present time is about 25,000,000 tons. This enormous production makes the company a correspondingly large consumer of coke for use in its furnaces. With the exception of a comparatively small percentage all the coke which is used is supplied by its subsidiary companies. The two principal operators furnishing this coke are known as the H. C. Frick Coke Co. and the U. S. Coal and Coke Co. The mines and works of the former are located in Pennsylvania in what is known as the Connellsville district, largely comprising Fayette and Westmoreland counties. Those of the U. S. Coal and Coke Co. are located at Gary, McDowell County, West Virginia. Both of these companies are operated along the same general lines. The H. C. Frick Coke Co. at present owns about 70 separate coal mines, each mine having its own set of ovens, which it supplies with coal. The number of ovens at each mine ranges from, approximately, 100 to 800, depending upon the output of the mine and other conditions. These are located close to the openings of the mines and conveniently arranged in relation to railroad sidings. The coke ovens are, with few exceptions, of the bee-hive type, into which the coal is introduced at the top. The residual heat and that of the adjoining ovens starts the coking process, in which the volatile portion of the coal is driven off through the top of the oven into the atmosphere. When all of the volatile matter is driven off, the bed of coke is raked out at the bottom and loaded into cars for shipment.

The continued increase in furnace capacity of the Steel Corporation calls for a corresponding increase in coke production. It is estimated that the new furnaces under construction will add at least 2,000,000 tons to the present productive capacity of pig iron. This will necessitate between 6,000 and 7,000 more coke ovens with the necessary additional mining capacity and machinery equipment. Similar conditions prevail in respect to independent furnaces.



Main Power House of the H. C. Frick Coke Co., at York Run, Pa.

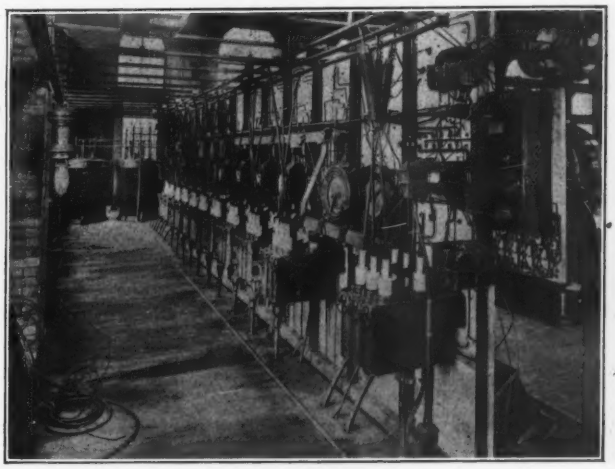
In coal mining power is used for operating haulage locomotives inside the mines, also for operating pumps which remove accumulations of water in the mines. A third requirement for power is for driving large ventilating fans.

In shaft and slope mines power is also required for hoisting purposes. The dictates of modern practice are to use electric motors of proper design for all the above requirements. From the mine the coal is carried to a tipple, whence it is discharged into what are known as coke oven larries. Those are small stool cars equipped with electric motors for propulsion and supplied with chutes for discharging the coal into the ovens. It is customary to arrange the ovens on either side of the track on which the larry runs; coal being discharged from both sides. The electric motors on the larries are small railway type machines. Electrically operated drawing machines are used for removing the coke from the ovens. The machine draws the coke out of the oven by a scraper, discharging it on to a conveying belt, whence it is dumped directly into freight cars. Two motors are used on this machine; one is of the series-wound railway type and the other a shunt-wound constant-speed motor.

The operations of the H. C. Frick Coke Co. at their York Run plant in Pennsylvania are of special interest on account of modern features. Of the ovens here, 100 are especially selected and so connected by flues as to conduct the hot gases from the ovens to the boiler house. The heat discharged from the coke ovens represents an enormous waste, and its use under the boilers therefore saves the use of a corresponding quantity of coal to produce the same heat; thus a large amount of heat is economically obtained at York Run. It is roughly estimated that the heat developed by each oven is the equivalent continuously of 18 horse power.

The power house is supplied with four A. C. generators rated 400 K. W., 2300-volt, 3-phase, 25 cycles, built by Allis-Chalmers Company. The equipment is complete with motor and engine-driven exciters. In the main power house is located a rotary converter sub-station supplied with two 200 K. W. rotary converters and six 75 K. W. step-down transformers. All the machinery in the power house is controlled by a large 17-panel blue Vermont marble switchboard with complement of oil switches, indicating and recording meters. The rotary converters supply direct current at 600 volts for haulage locomotives and coke-oven larries at the York Run mine. Alternating current is used for pumps, mine fans, hoists and scrapers. Within a radius of between two and three miles there are located at various points four additional rotary converter sub-stations; each is equipped with one 200 K. W. rotary converter, three 75 K. W. step-down transformers and complete switchboard. These sub-stations are located so as to supply both alternating and direct current for mining and coking operations required by one or more mines. The switchboard in the main station is provided with feeder panels for the sub-station feeder lines. By means of integrating and recording meters a record of the power consumption is afforded at each mining and coking operation.

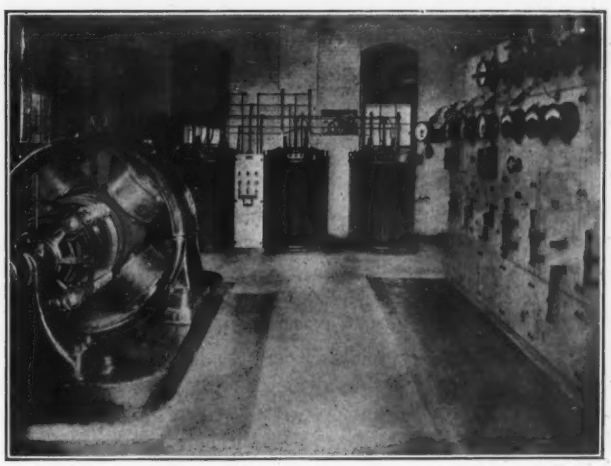
Additional mining and coking operations can be supplied from this same power house by running additional high-tension lines. Instances arise, however, where this is not practicable. Where locations are too remote, or when intervening property cannot be traversed by high-tension lines, it becomes necessary to install separate isolated plants. A number of such plants are now being installed to meet the increased demand for coke. At the Phillips Mines two 100 K. W., D. C. railway type generators with switchboards are being installed; also at Ronco mines, two 200 K. W., D. C. engine type railway generators with switchboards are being started, and at Dearth mines two 200 K. W., D. C. engine type generators with switchboard.



Rear of Main Switchboard, York Run Plant

The power house of the U. S. Coal and Coke Co. at Gary, W. Va., is equipped with two 24 and 42 x 42 cross-compound heavy duty Allis-Chalmers Corliss engines driving 750 K. W., 6,600-volt generators. In sub-stations there is a total of 27-75 K. W. Allis-Chalmers transformers used for rotary converters. The general lay-out of this plant is similar to that of the H. C. Frick Coke Co. at York Run, except that waste heat from the ovens is not used.

At the present time there is being installed for the Woodward Iron Company at Woodward, Ala., complete high-ten-



200 K. W. 3-phase, 25-cycle Rotary Converter in Sub-Station of York Run Plant of the H. C. Frick Coke Co.

sion machinery for their coal mining operations. The power house is being provided with four 400 K. W. engine type alternators. The current is generated at 3,300 volts, 3 phase, 25 cycles and transmitted at the voltage to the sub-stations which in this instance are located under ground in

the mine. These sub-stations consist of one 200 K. W. rotary converter and three 75 K. W. transformers complete with switchboard and lightning arrester equipment.

The Ellsworth Coal Company at Ellsworth, Pa., which has recently been acquired by the Lackawanna Steel Company, is arranged for the installation of a large A. C. central station for distribution of power. Owing to special conditions at this plant there are installed rotary converters running as belted generators; ultimately these machines can be used as rotaries receiving alternating current from the central station. At the present time a 500 K. W. railway type rotary is supplying power to two of the mines on this property. At one of the more remote mines a "Reliance' Corliss engine is driving a 500 K. W. generator.

PRINCIPLES OF ATMOSPHERIC PRESSURE

By W. H. Wakeman.

Judging by the statements made by correspondents in some of the mechanical papers, the operation of atmospheric pressure in connection with steam engineering practice is not clearly understood, and while we have no desire to direct our remarks at this time to any particular writer, we expect to make some explanations that should make the entire subject clearer to those who have not given it careful and intelligent study.

Everybody who knows anything about the theoretical part of steam engineering, is aware that the ordinary steam guage does not indicate the total pressure exerted, but that it does show the unbalanced pressure, which is all that is necessary to know so far as the practical working of steam engineering is concerned. However, there are many problems that engineers who wish to advance in their work until they become something more than "starters and stoppers," must master, and the effect of atmospheric pressure forms an important part of the work along this line.

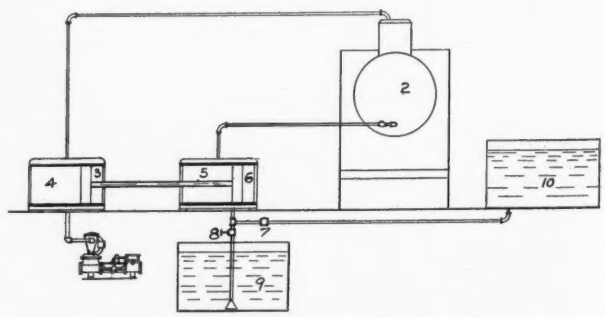
In the illustration 2 represents an ordinary tubular boiler, but any other kind might have been used to show the operation of the principle involved. Suppose that this boiler is cold and empty with the manhole cover removed. It is filled with air at say, 15 pounds pressure, to the square inch, and, of course, the same pressure is on the outside, therefore the boiler is in equilibrium and the gauge indicates zero of pressure. Next the shell is filled with water to the second gauge, the manhole cover put on and a fire built in the furnace. When steam begins to form it must first drive out the air, therefore, when the top of the shell and the steam pipe begin to get warm, it shows that air pressure at 15 pounds has been replaced by steam pressure slightly above atmospheric pressure. The excess is not great, but is barely enough to cause the air to move out, and the gauge still indicates zero of pressure.

The fire continues to burn briskly, and in about two hours we have steam at 100 pounds pressure by the gauge, but is it not clear that the total pressure is 115 pounds? This steam is conveyed by a suitable pipe to the cylinder shown, which represents the steam cylinder of a large direct acting steam pump. It enters the crosshead end 3, where it first drives out the air at 15 pounds pressure, then occupies the entire space shown at 3 by steam at 115 pounds absolute pressure or 100 pounds by the gauge.

Up to this time the other end of the cylinder 4 is filled with air at 15 pounds pressure, therefore the unbalanced pressure acting on this piston is 100 pounds, and this is indicated by the steam gauge. Under these conditions when the piston moves, it will travel from right to left.

In order to illustrate the point at issue we assume that the steam and the water piston in this case are of the same diameter, although this is contrary to general practice, as the former must be larger than the latter. When the pump piston moves from right to left, it will force water out of 5 through the feed pipe into the boiler against 115 pounds total pressure. Air pressure, or steam pressure due to the air at 15 pounds acts on the other side at 6, therefore the unbalanced pressure on this piston is 100 pounds.

This shows that taken as a whole the pump is in equilibrium, therefore it stands still, as there is nothing to move it. Below the steam cylinder there is a jet condenser running at good speed, and maintaining a vacuum of 26 inches, which is equivalent to removing 12 pounds of pressure in 4, as the condenser is now in direct communication with it. This action disturbs the equilibrium above mentioned, as there is a difference between 3 and 4 of 112 pounds, while the difference between 5 and 6 is 100 pounds as before, consequently, taking



Illustrating the Effect of Atmospheric Pressure

the two pistons together, there is an unbalanced pressure of 12 pounds per square inch acting to move the piston from right to left. This is sufficient to move it, hence, water goes into the boiler, but what drives it in?

If we reply that steam pressure did it our answer is correct, but the pressure was all there before the condenser was started, yet the pistons did not move. After it was put into operation they started at once, and when they reach the end of a stroke towards the left hand, a valve, which is not shown in the illustration, closes and shuts off communication with the condenser. Another one opens and 3 is connected with the condenser, the result of which is that all pressure shown by the gauge is removed, also 12 pounds of that due to the atmosphere, leaving only 3-pound absolute in 3. A total pressure of 115 pounds is admitted to 4 from the boiler, therefore

the unbalanced pressure in the steam cylinder is 112 pounds absolute.

The pistons now start on their journey toward the right hand, hence there is a pressure of 115 pounds in 6, and 15 in 5, making the unbalanced pressure 100 pounds as before, and taken as a whole the unbalanced pressure is 12 pounds for this stroke the same as on the other. This is not a form of perpetual motion, as the pump works in accordance with well-known natural laws, but the proper way of applying these laws is not well understood, and this is the point I wish to make in this connection.

In this case the gauge pressure is 100 and the atmospheric pressure 15 pounds, therefore the absolute pressure is 115, but it is all steam pressure, as above explained, because air cannot enter the cylinder with the steam, nevertheless, 15 pounds of it is due to the atmosphere. If this pump was located on a high mountain, where atmospheric pressure is 10 pounds, then the absolute pressure would be 110 pounds. The steam gauge would show the same pressure as it did on a much lower level (provided no change was made at the boiler) and the safety valve would open at exactly the same pressure on the shell.

Again, referring to the illustration, suppose that when the pump is running, the valve 7 is closed and 8 is open, thus drawing water from the tank 9. What causes water to rise out of this tank? While the pump is standing still there is a pressure of 15 pounds on the surface of the water, both inside and outside of the suction pipe, but as soon as the pump piston moves, some of this pressure inside of the pipe is removed, consequently, pressure acting outside of it forces water up into the pump, provided it is not too high above the water surface, for when it rises high enough to balance the weight of the atmosphere it will go no higher. Several ingenious devices have been invented, the object of which is to overcome this natural law and make it go higher, but they will not succeed until perpetual motion is discovered and made practical.

Suppose that 7 is opened and 8 closed, thus opening communication with the tank 10, which is supposed to be perfectly air-tight. The pump is started but cannot draw water. This is due to the fact that atmospheric pressure is not admitted to the surface of the water in this tank. Of course, it is possible to draw out a small amount, the same as it is possible to drink a small quantity out of an inverted bottle without providing an air inlet, but the limit is soon reached.

We once conducted an experiment to prove that water could not be drawn out of a closed tank, as some of our engineer friends thought that it could, but the results obtained seemed to warrant their belief, until it was discovered that the tank was not really air-tight as it was supposed to be. Other illustrations might be presented to show the effects of atmospheric pressure, but the above-mentioned are frequently encountered in steam engineering practice, and are sufficient to answer any purpose at this time, which is to correct erroneous ideas that are frequently expressed along this line.

Formulas for Gas Engine Fly-Wheels.

The following formula for the calculation of fly-wheels for gas engines is applied by Mr. R. E. Mathot in the "Engineering Magazine to all classes of engines. If, in the formula,

P = the weight of the rim (without arms or hub) in tons;
D = diameter of the centre of gravity of the rim in meters;
a = the amount of allowable variation;
n = the number of revolutions per minute;
N = the number of brake horse power;
K = co-efficient varying with the type of engine;

then, $$P = K \frac{N}{D^2 a n^3}$$

If D is transformed to feet, the formula will read:

$$P = K \frac{10.75\, N}{D^2 a n^3}.$$

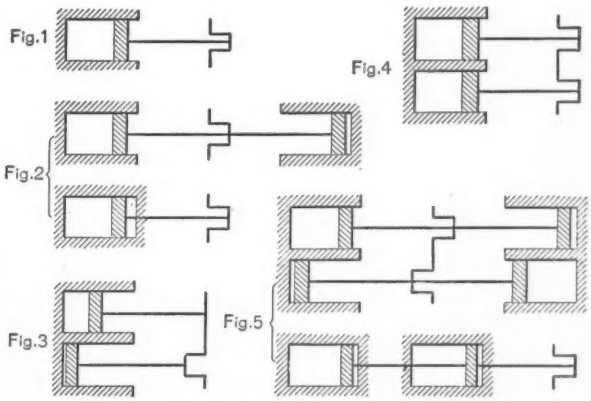


Diagram of Different Types of Gas Engines

The co-efficient K, which varies with the type of engine, is determined as follows:

K = 44,000 for Otto-cycle engines, single-cylinder, single-acting. (Fig. 1.)
K = 28,000 for Otto-cycle engines, two opposite cylinders, single-acting, or one cylinder double-acting. (Fig. 2.)
K = 25,000 for two cylinders single-acting, with cranks set at 90 degrees. (Fig. 3.)
K = 21,000 for two cylinders, single-acting. (Fig. 4.)
K = 7,000 for four twin opposite cylinders, or for two tandem cylinders, double-acting. (Fig. 5.)

The factor a, the allowable amount of variation in a single revolution of the fly-wheel is as follows:

For ordinary industrial purposes..... 1/25 to 1/30
For electric lighting by continuous current. 1/50 to 1/60
For spinning mills and similar machinery.. 1/120 to 1/130
For alternating current generators in parallel 1/150

The total weight of the fly-wheel may be conisdered as equal to $P \times 1.4$.

The total consumption of coal in the world is considerably over fifty thousand tons per hour. Of this enormous quantity about twelve thousand five hundred tons is required to heat the boilers of stationary, marine and railroad engines. The production of pig iron consumes over five thousand tons per hour. The average hourly consumption of coal in households is estimated at about ten thousand tons.

GROUND DETECTORS

By Jacob Glogau.

When the current in an electric wire escapes by any means to the ground, the wire is said to be grounded. These grounds are quite dangerous in some cases, while in others they are often put to practical use; for example, the neutral wire of the Edison three-wire system is sometimes grounded, and the negative wires of the street railway overhead wire system and third-rail system are grounded to the tracks.

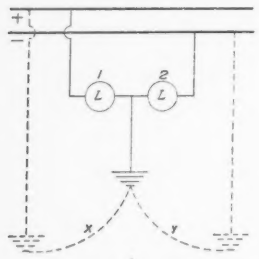


Fig. 1

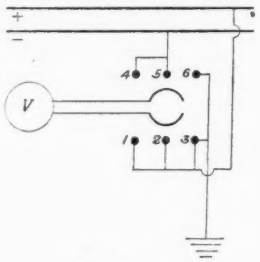


Fig. 2

If one of the wires of a two-wire system become grounded no serious trouble will occur. However, if the other side of the circuit should also become grounded, a complete circuit would be formed, blowing out the fuses, even though the circuit be protected by a circuit-breaker. Small grounds are difficult to detect, but heavy grounds are generally easily detected. If the generator is not protected by fuses or circuit-breakers, very peculiar noises will be heard, generally accompanied by a display of fireworks.

Ground-detectors are used to indicate a ground when one occurs, and also to give the engineer an approximate idea of the location of the ground. The simplest form of a ground-detector is that employing the ordinary lamps, the connections for which are shown in Fig. 1. Should a ground occur on the negative line, the lamp 1 will be bright, as it is receiving the line voltage current passing from the positive line through the lamp to the ground and then to the negative line, as indicated by the dotted line Y. The same is true when a ground appears on the positive line, the only difference being that the

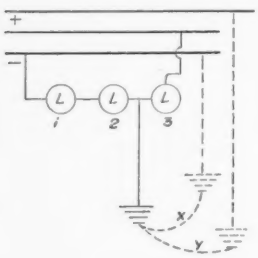


Fig. 3

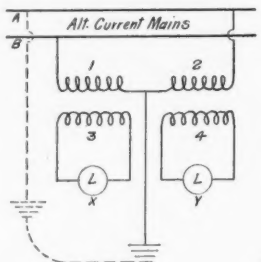


Fig. 4

circuit is completed by the dotted line X instead of Y. When the line is clear both lamps will be found to be burning at half their rated candle-power.

The more modern ground-detector is the voltmeter. The advantage it possesses over the lamp-detector is that of indicating very small grounds and giving an idea of the resistance of the ground. Fig. 2 shows the voltmeter used as a ground-detector and also as a recorder for the line potential. When the switch is connecting the points 2 and 5, the voltmeter, V, will indicate the line voltage, when connecting 1 and 6, any ground on the negative line will be indicated, and when connecting points 3 and 4, any ground on the positive line will be indicated by the voltmeter.

Although the neutral wire of a three-wire system is grounded, a detector of the lamp style is employed to indicate any grounds which may occur on the two outside wires. Fig. 3 shows the connections of the lamp detector used with the three-wire system. When a ground appears on the negative line the lamp 3 will burn brightly (the regular 110-volt, 55-watt lamps being used) as it is receiving the line potential of 110 volts; the circuit being completed through the ground as indicated by the dotted line X. Should a ground appear on the positive line, the lamps 1 and 2 will burn brightly, as they then become connected to the two outside wires, which carry 220 volts, the full voltage of the system, by the ground as indicated by the dotted line Y. When the line is in perfect condition the lamps 1, 2 and 3 will be burning dull, or at about one-third of their rated candle-power.

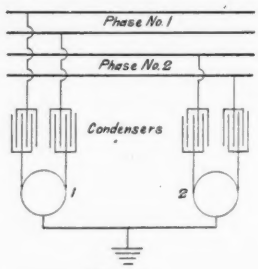


Fig. 5

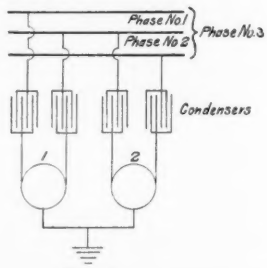


Fig. 6

Ground-detectors are used on alternating-current circuits the same as on direct-current circuits, the only difference being that a transformer is used in connection with the lamp detector, to reduce the voltage of the main line, so that it may be used for the lamps. The connections for an ordinary single-phase circuit are shown in Fig. 4. When a ground occurs on the line A the primary coil of the transformer, 1, will be connected to the line A, as shown by the dotted lines, thus completing the circuit. The current will then be induced into the secondary coil 3, lighting up the lamp X. The same occurrence takes place should a ground appear on line B, except that lamp Y will light up instead of lamp X. When no ground exists both lamps will burn at about one-half their rated candle-power.

In alternating-current circuits, a regular ground-detector is generally employed which involves the principles of electrostatics. Such a ground-detector consists of four fixed vanes, which are arranged around a movable vane made of aluminum, to which is attached the pointer. The vanes are connected in diagonally opposite pairs and then brought out to two terminals which are connected to the line wires; the movable vane being connected to the earth, or grounded. The primary plate

of the condenser is connected to line wires and the secondary plate is connected to the fluted vanes. Since the fluted vanes act inductively on the movable vane, the stress produced by each is equal, but in opposite directions; therefore the needle or point takes a position at the central point of the scale.

When a ground occurs the primary plate of one of the condensers and the movable vane become electrically connected, and the pair of vanes which are connected to that condenser assume the polarity of the movable vane and thus repel it. The other pair of vanes, however, attract the pointer, since they are of opposite polarity; thus, acording to the law of electrostatics—"like charges repel; unlike attract." As the two forces are acting in the same direction, one repelling and the other attracting, the pointer will indicate a ground on the side of the deflection.

Figs. 5 and 6 show connections of ground-detectors as used on two and three-phase circuits. Referring to Fig. 5, should a ground appear on line A, then detector 1 will indicate to the left; if on line B, detector 1 will indicate to the right; if on line C, detector 2 will indicate to the left, and if on line D, detector 2 will indicate to the right. Referring to Fig. 6, if a ground appears on line A, detector 1 will indicate to the left; if on line

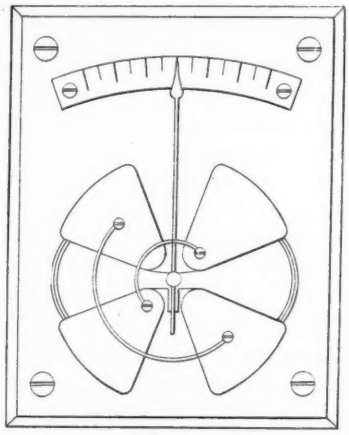


Fig. 7

B, the detector 1 will indicate to the right, and the detector 2 to the left, and if on line C, detector 2 will indicate to the right.

In Fig. 6 it will be seen that two detectors are employed, but an instrument is now being used for detecting grounds on a three-phase circuit, consisting of a dial with three pointers so that each phase has its own indicator. When a ground occurs on any line, the two needles which are adjacent to it will deflect towards the grounded line. When the ground occurs on two of the phases, the needle which is between the segments of the grounded line will deflect towards the one having the heaviest ground, and the two remaining ones will deflect towards the grounded segments.

The following few rules will be found to be very practical and useful to the engineer for making ground connections for the inside of power plants with potential from zero to 550 volts:

1. The size of the ground wire should not be smaller than No. 4 B. and S. gauge.

2. The ground wire should be connected to the system on the street or service side of the main cut-out; the connection being made by a properly soldered and tapered joint.

3. Ground connections should be made only on water pipes, on the street side and as near as possible to the building. This form of connection is to be clamped on to the pipe.

4. When ground wires pass through the walls of a building they should be protected by porcelain bushings.

5. Ground wires should be run as straight as possible.

The ground detector is a very important requisite in all branches of electrical work, as practically the first thing done in case of accident to electrical machinery is to test for grounds. Therefore, no matter how small a plant may be, the main instrument to be seen on the switchboard will be the ground detector.

Questions for Candidates Seeking Certificates as Hoisting Engineers.

The following questions were given at a recent examination for hoisting engineers held at Springfield, Ill.:

1. What are the laws in reference to duties of a hoisting engineer?

2. What are the laws in reference to persons going into the engine house?

3. What are the laws in reference to the care of engines and boilers?

4. With water at a temperature of 40° F., which would you use, a feed pump or an injector ?

5. We are using 12,000 pounds of coal in eight hours to do our hoisting and pumping and running our fan; we are putting water in the boiler at 40° F. How much coal will we use for the same work if we put water in the boiler at 95° F?

6. How would you prepare a boiler for cleaning?

7. What is an indicated horse power? Give data.

8. What is the law in reference to signals? Give the signals.

9. We have a tank full of water. It is 8 ft. diameter at the top and 12 ft. diameter at the bottom, and 12 ft. deep, and is a circular tank. We are using 32 4-horse power per minute. How long will it take to empty the tank?

10. If a boiler is allowed 150 pounds pressure per square inch with a thickness of steel .045 of an inch, tensile strength of steel 60,000 lbs. per square inch, what thickness should a 22-inch pipe be to stand the same pressure? Tensile strength of steel being the same.

11. How would you fasten a rope around a drum?

12. Give the breaking strain of ⅞ steel wire rope, also safe working load.

13. If you hear a pounding in the cylinder in the morning when you start your engine what would you think was wrong?

14. We have a lodge which is 26 ft. long, 8.5 ft. wide and 7.5 ft. deep. The lodge is full of water, how long will it take a 4-inch pump having a velocity of 100 ft. per minute to empty lodge? We have two 2-inch pipes running full in the lodge at a velocity of 100 ft. per minute each. Resistance of pump 10 per cent.

15. On a boiler 54 inches diameter with a grate bar surface 18 sq. ft., what size safety valve would you use if a common lever valve type, and what size safety valve would you use if a spring-loaded valve?

EXAMINATION QUESTIONS FOR ENGINEERS

A Set of Comprehensive Questions that can be Answered without the Use of Mathematics

By A. Edward Rhodes.

In looking over some old papers recently, I ran across a set of examination questions that were used a few years ago when we needed a new engineer. They differ from the usual run of questions in that they do not call for a knowledge of arithmetic. The kind of man we wanted was one competent to run a 200 horse power Corliss engine, look after the firemen, inspect and order the coal, and attend to ordinary repairs and adjustments.

The method of holding the examination was slightly different from the ordinary method, because, instead of taking the applicants into the office and handing them a piece of paper, with the remark, "Here are some questions that will enable us to ascertain your knowledge of theoretical and practical engineering,'" our superintendent first met the applicants, sized them up, and turned them over to one of the men in the shop, who was a former engineer, with the remark, "Jim, this is Mr. Blank who wants the job of running our engine. Take him out and show him over the place until I can get a chance to talk to him." Now here is where the applicant had a fair chance, because he was among familiar things and felt more comfortable than in the office. Also when Jim put the following questions to him, in an off-hand way, the applicant would answer with more freedom and better than he would if he felt that he was undergoing an examination. The fact that Jim was an engineer also gave the questions an innocent appearance. The questions asked were as follows:—

1. How do you like the engine?
2. Did you ever run this make of Corliss engine?
3. What kind of engine did they have where you have been working?
4. How many horse power was it?
5. What kind of an engine do you like best?
6. How long have you been working at the business?

The two men now talk about other things and walk over to the boiler room. The applicant by this time has overcome any feeling of bashfulness that he may have felt, and he may ask some questions that will throw light on his knowledge. Jim begins again:—

7. How long have you fired a boiler?
8. How would you fire up a new boiler ?
9. How long would you keep fire in the furnace before you began making steam?
10. If a new boiler leaked around the tubes, what would you do?
11. How would you get up steam after the boiler had been cold for a day or two?
12. What kind of a fire do you like, a thick or thin fire, using either hard, soft, or slack coal?
13. Do you keep your ash-pit dry or do you run with water in the ash-pit?
14. Do you ever let ashes accumulate in the ash-pit?
15. Do you prefer a rake or a slice-bar for stirring the fire?
16. Do you shut the damper while you are working with the furnace doors open?
17. Do you favor a scraper or a steam blower for cleaning boiler tubes?
18. How many gauges of water would you carry in a horizontal return tubular boiler?
19. Do you trust to gauge glass or do you use the gauge cocks also?
20. How often would you clean out connections of the gauge glass and gauge cocks?
21. Which inspirator or injector do you like best and why?
22. Did you ever have a safety valve stick fast, and how do you prevent its sticking?
23. Do you keep the feed running in a steady stream, and do you let the water run low and then pump until the gauge glass is full?
24. Do you ever scrape the dirt from the fusible plug?
25. How often do you take out the man-hole and inspect for scale, broken stays, etc.?
26. Did you ever insert a torch on the end of a pole and examine the bottom of the shell for mud?
27. Did you ever have plates over the fire-box sag from getting red hot due to the absence of water caused by a pile of mud?
28. How low would you let the water get before you pulled your fire?
29. How do you bank a fire?
30. Can you tell good from poor coal by inspecting it?
31. What kind of coal do you prefer?
32. If your pump gets hot and refuses to throw water, what would you do?
33. With how many methods are you familiar for making a feed pump return to duty, when stopped on account of hot water, air, or defective suction?
34. Would you, under ordinary circumstances, open the flue doors and allow cold air to impinge on the boiler head and into the tubes?

By this time the superintendent "happens" along and after a few minutes conversation on things in general, he asks:—

35. What makes grate bars burn out quickly, and what treatment will preserve them a long time?
36. Would you allow clinkers to attach themselves to, and remain in, the corners of the fire-box?
37. How often do you blow off the boiler?
38. Of what use is a surface blow-off?
39. Under how many pounds pressure per steam gauge would you blow-off a boiler?
40. Would you empty a boiler immediately after a long run, or while the bricks and boiler are both very hot?
41. Give me your opinion of boiler compounds?
42. If this boiler should scale what would you do?

43. Do you ever get drunk?

44. Do you ever drink or bring liquor to the engine room, either in your pocket or in your stomach?

45. Do you read THE PRACTICAL ENGINEER and other good engineering literature?

46. What would you do if a plain slide valve should slip an eccentric while in your charge?

47. Can you adjust the valves of Corliss engine?

48. What would you do if you suspected that the crank shaft of the engine got out of line?

49. How would you determine whether the wrist plate ran true or not?

50. What do you understand by the terms "lead" and "compression."

51. Are you up in the theory of the indicator?

52. Have you had any practice with the indicator, and can you use it intelligently?

The above questions, in our opinion, decided if the applicant had or had not studied before practicing his vocation. The answers had to come quick and be to the point, just as he would have to do in any emergency. We wanted a man whose hands and brains act together, and any may who cannot give a satisfactory answer to every one of the above questions has no business in the engine room. The drink question was purposely fired at them at a time it was not expected, and the evasive answer, so often previously prepared, did not have a chance to crop up. A large majority of the applicants failed because they could not give satisfactory answers to the rum questions, many of them good men, too. But as we believe that one-third of the boiler explosions are caused by the use of liquor, our engineer must be a total abstainer. Our own lives depend upon it.

ELEMENTARY PRINCIPLES OF ENGINE DESIGN

By R. D. MUMFORD.

The steam engine is known by all as a piece of machinery designed to do certain work, but very few stop to consider how it is designed, and how it is known that the engine will perform the work before it is built. Let us therefore proceed with the first fundamental principles of the simple steam engine, taking each part from start to finish, and assuming figures and diagrams which will be best suited and most convenient in giving a clear explanation.

We know that the engine receives its energy from steam, which is generated in a boiler and carried by means of pipes to the steam-chest of the engine. The steam which is now in the steam chest is to be distributed to the cylinder, and this is accomplished by means of a valve, the most common form of

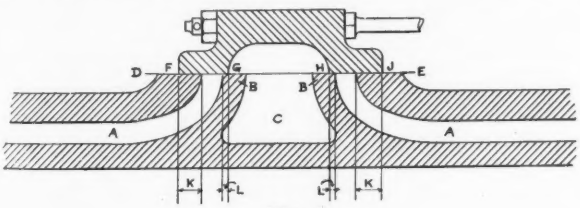


Fig. 1

which is the D-slide valve, which takes its name from the shape it represents. Fig. 1 shows this type of valve in mid-position; AA being the steam ports, or passages through which the steam travels from the steam chest to the cylinder; BB are the bridges, C the exhaust port, and DE is the sliding surface for the valve and is called the valve seat. The flanges of the valves, FG and HJ, are seen to be greater in width than the ports AA, which they cover, and of this extra width KK is called the outside lap and LL the inside lap. Another common type of valve which is used quite extensively is the piston valve, which has the principles and workings of a D-slide valve, except that it is circular instead of flat.

In Fig. 2 is shown a skeleton diagram of the relative position of the valve and piston at the point of beginning a stroke. In Fig. 2, AB is the crank, AC the eccentric, BD the connecting rod and CE the eccentric rod. Now suppose the crank to be turned forward in the direction of the arrows, the valve will begin to slide, thus admitting steam into the left-hand steam port F from the steam pipe L through the steam chest, until the point C of the diagram is at G, the point B at H, and the piston at the other end of the cylinder, as shown dotted. The engine has now made half a revolution and now begins its return stroke. On the return stroke the valve closes the steam port F and the piston which is now receiving steam, through the steam port J, forces the steam which was used for the downward stroke out through the exhaust port K. Thus the running of the steam engine is merely a repetition of this motion, back and forth.

To ascertain, theoretically, the dimensions of some of its

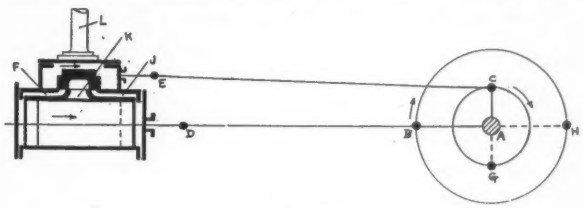


Fig. 2

principal parts, suppose we have a mean effective pressure of fifty pounds per square inch, that is, fifty pounds as the average pressure tending, to push the piston forward during its entire stroke in one direction, less the pressure resisting its advance. This mean effective pressure can be accurately determined by laying out the theoretical indicator card and taking the area of the card in square inches and dividing by the length of the card and multiplying by the scale of pounds to which it was drawn. As an illustration, suppose we found the area of a card to be 4.7 square inches, the length 3¾ inches and the scale 40 pounds to the inch, then the mean effective pressure is equal to $(4.7 \div 3.75) \times 40 = 50$ lbs. per square inch.

Now assuming we require 70 actual horse power, the stroke to be 20 inches, and 180 revolutions per minute, we would then require a piston speed of 600 feet per minute, which may be found by the following formula:

$$S = (L \times 2R) \div 12, \text{ or, } (20 \times 2 \times 180) \div 12 = 600$$

feet per min.

This piston speed is perfectly safe, as a piston speed of from 300 to 600 feet per minute, for simple steam engines, is considered good practice.

We have previously assumed that we required 70 actual horse power to perform the work, then the indicated or theoretical horse power would be (assuming 80% efficiency for the engine) $70 \div 0.8 = 87.5$ horse power. Now, using the old familiar formula H. P. = PLAN ÷ 33,000, the area of the cylinder in square inches would be

$$A = (33{,}000 \times \text{H. P.}) \div PLN.$$

Where P is equal to the mean effective pressure, L is the length of the stroke in feet and N is the number of strokes per minute. The formula then becomes

$$\frac{A = 33{,}000 \times 87.5}{50 \times (20 \div 12) \times 180} = 193.2 \text{ square inches.}$$

The area of the cylinder is then equal to 193.2 square inches and the diameter corresponding to this area will be about 15¾ inches.

The following formulæ will be found to give satisfactory results in practice, and are such as can be easily understood:

(1) The thickness of the cylinder in inches, a good allowance being made for re-boring, is found by the following:

$$T = \frac{D \times P}{4000} + \tfrac{5}{8}''$$

Where D = the diameter of the cylinder in inches and P = the pressure.

(2) The cylinder cover thickness is equal to the cylinder thickness plus ⅛" in small engines up to plus ½" in large engines.

(3) The cover bolts should be of such a diameter and number as to keep the cover joint perfectly tight, but in no case should they be less than ⅝" in diameter. The diameter is found thus:

$$d = D\sqrt{P} \div nf$$

in which D = the diameter of the cylinder in inches, P = the pressure per square inch, d = diameter of the bolt at root of thread, n the number of bolts, and f = the stress per square inch, usually taken as 3000.

(4) The depth of the piston is usually made about .3 the diameter of the cylinder and the diameter of the steel piston rod is equal to

$$\text{diameter of cylinder} \times \sqrt{\text{boiler pressure}} \div 60.$$

(5) The crosshead pin is usually made the same diameter as the piston rod for simple engines, and the pressure on the pin should not exceed 1,200 pounds per square inch, and the pressure per square inch on the cross-head should be about 50 pounds.

(6) The main steam pipe should be well covered to prevent a loss of pressure from the boiler to the engine, and should be of such a diameter that the steam velocity does not exceed 6,000 feet per minute, and the exhaust should have a velocity of about 4,000 feet per minute. The diameter of the steam pipe is equal to

$$\frac{\sqrt{\text{dia. of piston}^2 \times \text{piston speed in feet per minute}}}{6000}$$

And the diameter of the exhaust pipe is equal to

$$\frac{\sqrt{\text{dia. of piston}^2 \times \text{piston speed in feet per minute}}}{4000}$$

The full area of the steam port in square inches is equal to

$$\frac{\text{dia. of piston}^2 \times \text{piston speed in feet per minute}}{6366}$$

And the area in square inches of the port opening to steam is equal to

$$\frac{\text{dia. of piston}^2 \times \text{piston speed in feet per minute}}{8912}$$

The fundamental principals of the simple steam engine which have been given are sufficient to begin the actual design; but, however, the judgment of the designer must be exercised in determining the thickness and clearance required for the less important parts.

———o———

Economical Pumping Plant of the Omaha Water Company.

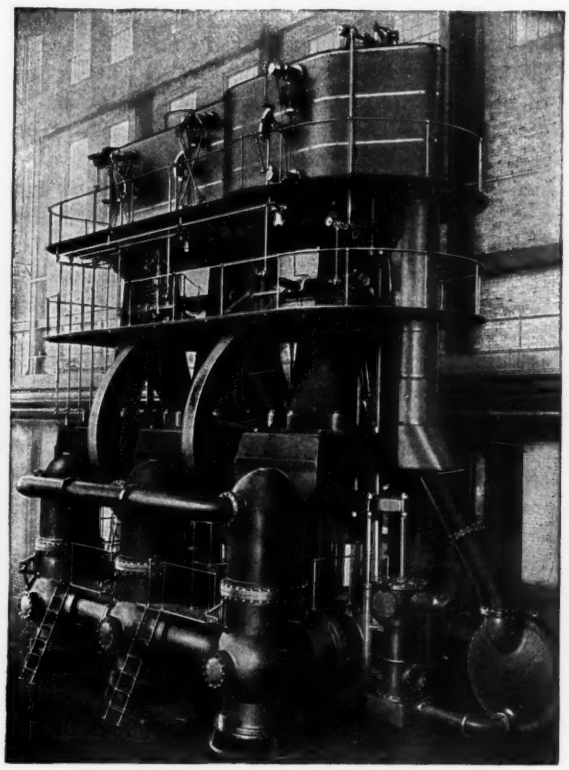
From the standpoint of high economy continuously maintained throughout a long period of time, the central station of the Omaha water works system has a record of more than ordinary interest, as will be seen from the following account.

The construction of this system was begun in 1880, when the population of the city was only 30,000, and completed in 1883. When completed, the system had 28 miles of water mains and 250 fire hydrants. The Missouri River was the source of supply. The water was first pumped up about 30 feet to four large basins on the river side, where sedimentation took place, considerably clarifying the water. The clarified water flowed to the suction of the high-lift pumps, which discharged to a 10,000,000-gallon reservoir on Walnut Hill. Water was supplied to the city of Omaha, South Omaha, and the suburbs of Dundee, Florence and East Omaha. In 1886 the average daily consumption was about 6,000,000 gallons.

In 1887 a new central pumping station was built at Florence, Neb., which is located several miles up-stream on the Missouri River, beyond all danger of sewage contamination to the water. The plant is surrounded by 107 acres of parked ground, and is called by the Indian name for pure water, viz.: Minelusa. The mechanical equipment of this plant is particularly fine. Although some of the machinery has been in operation for nearly 20 years, the record for economy and reliability is most creditable and comparable with pumping plants built 10 or 15 years later. The low service and high service pumps are installed in the same station, and supplied with steam from a common boiler plant. The first installation consisted of two 12,000,000-gallon vertical compound, crank-and-flywheel pumping engines to work under a head of 70 feet for the low service, and one 18,000,000-gallon vertical, triple-expansion pumping engine to work under a head of 310 feet for high service, discharging to reservoir and distribution system. The low service pumps deliver the water to a series of sedimentation basins on the bank above the river, these basins being arranged with a series of cascades between adjacent basins, with water levels carried so as to give a drop of 2 or 3 feet

over each series of cascades. The cascades have sills perfectly level, and long enough to carry the maximum amount of water in a very thin sheet. Air is admitted freely behind the falling water. This complete aeration of the water, alternated with complete rest in the sedimentation basins, has a wonderful clarifying effect, and practically removes all of the red silt from the river water by the time it reaches the last basin. The clear water flows to the high-lift pumps under a slight head.

In 1898 the increase in water consumption demanded additional pumping capacity, and an 18,000,000-gallon vertical compound pumping engine was installed for low service duty, and a little later, in 1902, a 20,000,000-gallon vertical, triple pumping engine was installed to give increased capacity for high service system, making in all five Allis-



Vertical Triple-Expansion Pumping Engine in Plant of the Omaha Water Company

Chalmers pumping engines, with an aggregate capacity of 80,000,000 gallons per 24 hours. All of these pumping engines have records for reliability, as there has never been a break requiring a shut-down for repairs.

The first vertical, triple-expansion pumping engine has the following cylinder diameters: H. P. 40"—I. P. 70"—L. P. 104", and the stroke of all is 60". These cylinder sizes were very much larger than anything ever designed for pumping engine work at that time. The total weight of the machine was about 1,500,000 pounds. The introduction of this unit reduced the consumption of fuel 50 per cent., and for some years was claimed to be the most economical pumping engine unit in service, requiring but 1½ pounds of coal per H. P. per hour.

The second vertical, triple-expansion pumping engine has steam cylinders of the same diameters as corresponding cylinders on the first engine, but the stroke is increased to 66". Each pumping engine makes 20 revolutions per minute, and the second machine has 10 per cent. greater capacity on account of the longer stroke. The second machine is of the "self-contained" type, with the steam engine supported by the pump chambers. There are now 230 miles of water mains, and about 15,000 service connections to the Omaha water system.

Large Power Plant to Be Built on the Sacandaga River, N. Y.

Preliminary work has been begun on a large power dam on the Sacandaga River, in the northern part of New York State. When it is completed a lake will be formed forty miles long and three miles wide, which will give out about 200,000 horse power. The dam, it is calculated, will be about a mile long and 100 feet high at its highest point, and will be built of solid masonry. Its power will be used in conjunction with that of Spiers Falls power plant, which is several miles below the mouth of the Sacandaga River, which empties into the Hudson River. Already the big dam at Spier Falls, the fourth largest dam in the world and probably the largest dam constructed exclusively for power purposes, is taxed to provide energy enough to meet the requirements. The radius of influence of Spier Falls, narrow at first, gradually spread, until now its power runs the street cars in Albany, Watervliet, Schenectady, Rensselear, Cohoes and Waterford; lights the streets in many of those communities and furnishes power for many manufacturing plants. The greatest factor that has decided the development of the Sacandaga power is the application of electricity to the railroads of the State.

The Value of Balance Plates.

In order to determine the effect of the balance plate in reducing the work required to drive the valve gear, Mr. J. V. Standford, in the "Journal of the Franklin Institute," describes the results obtained from experiments made at the Mechanical Laboratory of the University of Pennsylvania with a 6"x 9" Sturtevant blower engine. It was found that the power used with the balance plate on was 0.25 horse power, and that it remained practically constant for varying pressures in the chest. Without the balance plate, the power required increased with the pressure and amounted to 0.38 horse power for the pressure previously used. While the saving shown here is slight, the value of the balance plate for much larger valves is unquestioned, and no doubt results in a net saving when the parts are in perfect working condition, but it would seem that in a small engine receiving the ordinary care, its presence may become detrimental in the course of time, owing to its tendency to increase the leakage due to poor contact between the valve and seat.

The bursting of a thirty-ton fly-wheel at the works of the Youngstown Iron and Steel Roofing Company at Youngstown, O., on August 5, killed Archibald Rankin, the chief engineer, and seriously injured six others.

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Velocity of Steam in Pipes.

When selecting the size of a steam pipe for any given purpose, there are two courses which are open to the designer; one is to select a small and comparatively inexpensive pipe with a large pressure drop and the other is to select a larger and costlier pipe, with greater radiating surface.

If a small pipe is selected for a given flow of steam, the losses of pressure are due to the energy which must be used up in producing the given velocity through the pipe, the greater the velocity the greater the loss, and the expenditure of energy along the pipe line due to the friction of the walls of the pipe and the change in direction around bends and through contractions. This total friction loss for any given pipe is proportional to the square of the velocity, the length of pipe and the density of the steam, and inversely proportional to the diameter of the pipe.

When a large pipe is selected, these friction losses are much reduced, but the increase in diameter means larger radiation surface which is proportional to the circumference of the pipe and its length. If the loss in friction on the interior of a pipe could be accurately measured, the size of pipe for any given case could be more easily determined by equating the two conditions and noting the diameter which would give the minimum loss.

In designing a steam pipe, therefore, it is advisable to make the number of bends in the pipe as small as possible and the number of valves should be reduced, as far as practical, to a minimum if a small amount of drop in pressure is desirable. But if a large drop in pressure is considered more advisable than a small drop, with its increased cost of pipe, then it might pay better to run the boiler at a pressure well above that desired at the engine and force the steam through a smaller pipe at high speed. This involves a stronger boiler due to the higher pressure at which the steam must be generated.

Taking all the above facts into consideration, with practice as a guide, it has been generally found that a velocity of steam of from 5,000 to 6,000 feet per minute will give the best results when designing the diameter of pipe based on the quantity of steam which must flow through it.

—o—

Engineering Simplicity

The young man who is about to start out in the profession of engineering, or the young engineer who has been in the business for several years, is often heard to exclaim that an engineer at the present time has much more to learn to become an engineer than those who started out twenty years ago. This will generally be disputed by the older engineers, who claim that a quarter of a century ago steam engineering was not the exact science that it is to-day, and that there were as many difficult problems to meet then as there are now.

It must be remembered that about twenty years ago, although there were not so many types of prime movers or so many applications of power, the engineer did not have so many advantages in the selection of power-plant apparatus that he has to-day, and while his knowledge of engineering apparatus did not have to be so comprehensive, perhaps, yet he had to be more ingenious in the use of what was at his command.

During the period of time under discussion, the use of electricity may be said to have been born and grown to mature age, the high-speed engine has caused the slower-speed engine to look to its laurels, the water-tube boiler has given the cylindrical boiler a race for its life, the use of belts and ropes for the transmission of power has been largely replaced by the electric wire, the gas engine has sprung from a toy to a respectful piece of apparatus, the elevator has changed from a simple system of ropes to a complicated mechanism, and the steam turbine has become a useful prime mover instead of a historical wonder.

What has all these changes meant to the operating engineer? Is the power plant any more complicated than it was some years ago? Compare a large plant, built fifteen years ago, and one built during the past few years, and what seems to be the most striking feature? Broadly, it is the tendency toward simplicity. Where many of the older plants have a heterogeneous assortment of different apparatus, the newer plants of to-dav have a more simple lay-out, and a more uniformity of size and types of apparatus.

With the exception of the elevator, which, with its numerous safety devices and complex mechanism, is becoming more and more troublesome, the general tendency of engineering is toward simplicity, because simplicity in general usually means reliability. If, then, it is true that power-plant apparatus and power transmission are more simple and better constructed, does not this mean that engineers can better understand them, and more easily and economically operate them?

Whether, however, engineers agree that simplicity of engineering is more noticeable at the present time than in the past, the tendency of those who control the lay-out, installation and manufacture of power-plant equipment, is toward that end.

One Hundred Years of the Steam Boat.

By a strange coincidence, just as the flags in New York harbor were paying tribute to the memory of Robert Fulton's successful effort in inventing the first steamboat one hundred years ago, one of the largest and most magnificent steamships afloat came into that same harbor on its maiden voyage and very fittingly did homage to the inventor of the first successful steamboat. It represented to the thoughtful mind, the alpha and omega of marine engineering in the past century.

The beginning of practical steamboat engineering began when Robert Fulton, in 1807, successfully navigated the waters of the Hudson River with his steamboat, "Clermont," and from that date the history of the steam navigation begins. The centennial anniversary of this event may have passed unnoticed if it were not due to the fact that the tendency of modern times is to give as much, if not more credit, to the successful men in art and science as is given to the warriors and statesmen of the past, because it has come to be realized that without the successful inventor, we could not have made the wonderful progress and have enjoyed the pleasures of this "mechanical age," which we are now having. No greater tribute can be paid to men of war and bloodshed than to the man who has burned the midnight oil and often sacrificed his life for the advancement of humanity. Fulton, Watt, Franklin, Volta, Morse, Davy, Henry, Stephenson, Corliss are only a few of the many inventors whose lives have been mile posts in the history of scientific progress and the American youth pores as faithfully over their life's history as that of any general or admiral.

This was not so a few years ago, and the advance in interest which the public is taking in engineering events shows the progress which this branch of technical training has been making.

The latest type steamship, which is the newest to have been placed in regular trans-Atlantic service, is the Kronprinzessin Cecilie. It is driven by four quadruple expansion engines, having a combined horse power of 45,000. Sixty-one engineers, oilers and electricians and two hundred and thirty-one firemen and coal passers are required to keep the boilers and engines in operation. It is 706 feet long with 72 foot beam. In comparison the "Clermont" was 133 feet long, 18 foot beam and 7 feet in depth. The engines were coupled to the crank shaft by a bell crank and the cylinders were 24 inches in diameter and 4-foot stroke. It made the first trip from Albany to New York, a distance of 150 miles, in 32 hours, and returned in 30 hours, being the first voyage of any length made by steam power.

Not only did New York remember the centennial anniversary of Fulton's first steamboat, but Philadelphia, Boston and other ports remembered the event. Engineering societies held banquets in honor of the occasion, and for the first time Fulton's achievements took rank with those of other inventors. His old home, near Lancaster, Pa., where most of the problems of the "Clermont" were solved, was recently sold for a small sum. It would be fitting, however, if some engineering society would purchase the property and thus perpetuate his memory as is done by many historial societies when they purchase the homes of patriots and heroes of military strife.

Setting of Generators.

In the case of a direct-driven generator, a footing common to the engine and generator, and, extending under all, is often built interlocking all foundations. This arrangement is strongly recommended. The foundation may be built of stone, brick, or concrete, and should have a batter of at least five to one. The top of the foundation should be leveled off carefully and finished to receive the cap plate on which the generator rests.

Belt-driven generators are usually mounted on separate rails provided with jack screws, or directly on the base frame with no provisions for sliding. This latter practice is not usually to be recommended, as it necessitates the use of an idler for tightening the belts. Where a wooden base frame is used, it should be carefully leveled and firmly secured in place with foundation bolts. The holes for the foundation bolts should be countersunk so that no part of the nut or bolt will come within half an inch of the top surface of the base frame. The spaces between the timbers of the frame should be filled with brick or cement, making the top of the foundation level. Where rails are used they should be carefully lined up and secured by lag screws.

The frame should, in all cases, be electrically grounded. This precaution is necessary to prevent accident in case the insulation should be punctured.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Some Valuable Points on the Care of Gauge Glasses.

EDITOR THE PRACTICAL ENGINEER:

In answer to W. J. G., July Practical Engineer, I offer the following suggestions. I have two Sterling Boilers, 150 pounds pressure. On taking charge I was informed that there was great trouble from breakage of gauge glasses. The glasses are 13 inches x ¾ inch (a long glass for a high pressure). The packing used was lampwick and asbestos, I insisted on getting proper rubber washers, was refused them, "kicked" some more, and finally they came. Their use reduced the number of breakages fully fifty per cent.

A more equal strain can be got with a rubber washer than with a lampwick grommet. To get lampwick tight considerable more pressure must be put on the nut and consequently on the glass, as the expansion of the lampwick is not so great as that of rubber. A rubber washer may be put up fairly firm and the expansion will do the rest.

The glasses should be of the best quality. The strength of the glass entails the use of proper material and proper tempering in the making, so as to produce a glass free from flaws and of even strength. Like all good things, a first-quality glass costs more than the seconds, and is cheaper in the end.

When a glass has "busted," before putting in a new one, and after cleaning out all broken pieces from the stuffing boxes, stand to one side and open each one of the glass cocks, first the upper and then the lower one for a second or two, and give the stuffing boxes a blow to clean them out thoroughly. A very small grain of broken glass, if left in the stuffing box, will grind against and crack the new glass when tightening the gland.

Most important of all, when the glass blows out and you grab a new one to get ready, drop the new glass into a pail of scalding water and let it temper until you get ready for it. A couple of minutes tempering often saves half an hour's extra labor. Heating the glass beforehand allows it to expand evenly outside as well as inside and it is fitted to assume business at once when the pressure goes on, because when the pressure goes on a cold glass, the inside expands more quickly than the outside, owing to the thickness of the glass.

Lastly, take up on the nuts evenly, a little at a time on each. When they are up just firm, stop, open glass drain, open steam glass cock and blow steam through to warm up the glass thoroughly, then open water cock and shut glass drain easy. If the glass leaks a little at the glands, give it a chance to take up for an hour, then if the leak has not stopped, shut off pressure, open drain, and tighten the glands a little. Some men, when in a hurry, do not stop to shut off the pressure, or they may shut off pressure and not open the glass drain. I know one experienced engineer who lost an eye by a glass blowing in his face and after he had shut off the two glass cocks, and was taking up on the nuts. He had not opened the glass drain and the glass held the boiler pressure of two hundred pounds.

If W. J. G. is using good quality of glasses, has exercised proper care to see that his upper and lower glass cocks are in line with each other, and set square in the column, and that the threads of the nuts or of the glands have not become crossed, also that the glass is not subject to a sudden draught of cold air, as from the sudden opening of a door or window, I think that he should fare about as well as the rest of us. A very frequent variation of water level from extremely high to quite low will often cause breakage.

To sum up; it would seem that W. J. G.'s troubles are caused either by improper fitting of his glasses, or by the position of the glass being too exposed to interference from outside sources, such as vibration of pipes or draft conditions, thus subjecting the glass to unequal expansions.

New York, N. Y. C. M.

Putting in a New Water Glass.

EDITOR THE PRACTICAL ENGINEER:

In looking over your valuable paper, I notice that W. J. G. cannot make his water-glasses last. I would suggest to Mr. W. J. G. that the next time the water-glass breaks that he shuts off the steam and water, takes off the glands, cleans and oils them, and puts in some rubber washers. Then see that all the old glass is out, as sometimes little pieces may get lodged in the top or bottom connections. Blow out the connections and adjust the glass; screw up the glands snugly, both ends alike; dont' let the glass turn around, but hold it still; be sure and have the combination valve opened when you turn the steam on; let the steam blow in your ash-pit; when the glass is expanded turn on the water; good judgment is the principal thing required.

Fall River, Mass. A. J. C.

Care of Steam Valves.

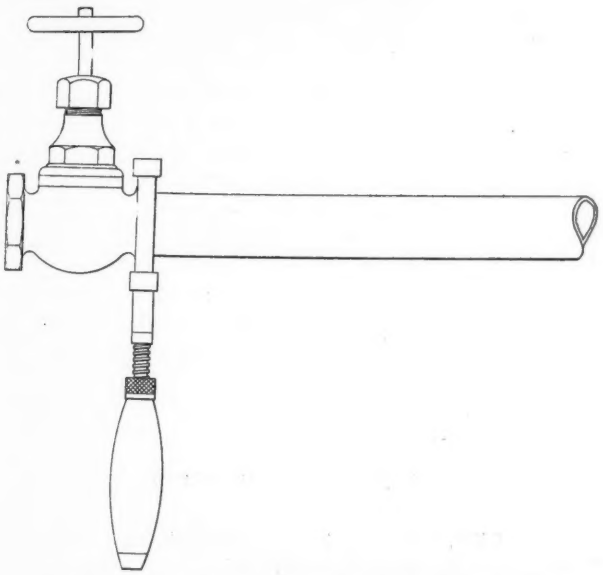
EDITOR THE PRACTICAL ENGINEER:

The many errors which are made in connection with the use of valves suggests that a few remarks on this important subject will not be out of order.

One of the many reasons why a valve will leak may be attributed to either incompetency or carelessness when placing them in the lines. The practice of applying a wrench on the hexagon farthest from the pipe, when screwing it on, will distort the valve and spring the seat out of its true shape. The valve should be closed when screwing it on the pipe, as it will be then more rigid than if it were open.

A valve should not be allowed to carry the weight of a

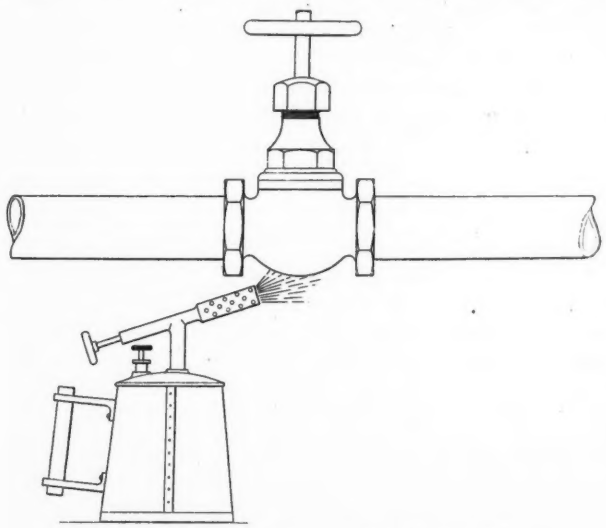
line of piping, as this may cause the seat to get sprung. A hanger properly placed, so as not to prevent free expansion and contraction of the pipe, will avert the trouble. If pipe grease is used to make the joint it should be put



Wrenches should always be used on Near Side of Valve

on the pipe and not on the valve, because when steam is turned on, the grease may be carried to the bearing parts of the valve and, owing to its sticky nature, it will catch and hold the grit and scale causing trouble with the seat and disc.

Steam valves should be closed tight because when they



Torch will help to Remove Sticky Bonnets

become cool they contract and any leakage passing through will wear an uneven bearing on the disc besides collecting foreign substances, and should they be closed when the valve is found to be leaking, it is probable that there will be a piece scale from the pipe found between the disc and valve seat.

When a pipe line is connected up, all valves should be left wide open and the pipe well blown out before they are closed in order to remove the loose scale or metal chips from the line. Only the required length of thread should be cut on pipes that screwed into valves; if the thread is cut too long, the end of the pipe will shoulder against the valve seat causing it to spring and leak.

Never place the body of a valve in a vise while it is undergoing repair. The proper method is to screw a piece of pipe in the valve and place the pipe in the vise. If the bonnet is obstinate in coming loose, a jerk or jar is preferable to a steady pull; if found impossible to remove in this manner, heat the bottom of the bonnet with a blow-torch and then tap around the threads with a soft hammer and the bonnet may easily be removed.

Do not remove or replace the bonnet without first having the valve wide open. An old worn monkey-wrench should not be used on a valve as the corners will become worn off and they will look unsightly, which is convincing index of the man's experience in charge.

Brooklyn, N. Y. J. G. S.

Lack of Oil Caused Jerky Governor.

EDITOR THE PRACTICAL ENGINEER:

On page 22 of the July issue of THE PRACTICAL ENGINEER, I noticed a letter by E. P. entitled "Remedy for A. C.'s Governor Trouble," which reminds me of an experience I had in that line some few years ago.

The engine in question was of the four-valve type of a well-known make, comparatively new, and had always given the best of satisfaction. One day as I was standing in another engine room, through which the free exhaust from this engine passed on its way to the atmosphere, I noticed something unusual in the sound of the exhaust steam as it rushed through the pipe. It would throw the back pressure valve wide open for a few seconds and then the valve would close tight, only to be thrown wide open again the next instant.

Stepping to the engine room door, from which place I could plainly see the engine, it took only a second to satisfy me that the machine was racing spasmodically. Feeling assured that the engine could not run away, it being fitted with an automatic safety stop attachment, I walked over and watched it, with my hand on the throttle in case it would become necessary to stop it. As I stood by the engine I noticed that the governor, which was of the high speed, inverted, counter-weight type, would almost come to a stand still due to sticking. In such a case the weights would naturally drop to a lower plane and thus admit more steam, causing the engine to race. Then the governor would start again with a jerk, throwing the weights to their highest plane, thus shutting off the steam supply as the valves would not hook. The engine was allowed to run in this condition till noon, when it was shut down.

After shutting the engine down and removing the governor belt it was found to be impossible to turn the governor by hand. An examination of the governor disclosed the fact that no means had been provided for getting oil between the two rubbing surfaces, just below the counter-

weight. Although a saucer cup had been provided, which was always kept full of light, clean oil, it was of no use as there were no oil grooves to allow the oil to reach the wearing surfaces.

Having but a limited time in which to repair the governor, only temporary repairs could be made, and the following is the way I went about it. When the governor weights and the counter-weight were raised as high as they would go, it was noticed that when in that position the two collars came apart a very small distance, but sufficient to allow light oil to penetrate between them. This was done a few times when it was found that the governor could be turned by hand. The governor was then run at a speed sufficient to throw the weights to their highest plane, thus keeping the two collars separated and allowing the oil to work in and out and clean the surfaces which were full of grit. After removing the oil in the saucer and putting in a supply of clean oil, no further trouble was experienced with the governor. However, each time the engine is shut down I raise the governor weights and oil the surface btween the collars, keeping it clean and well lubricated.

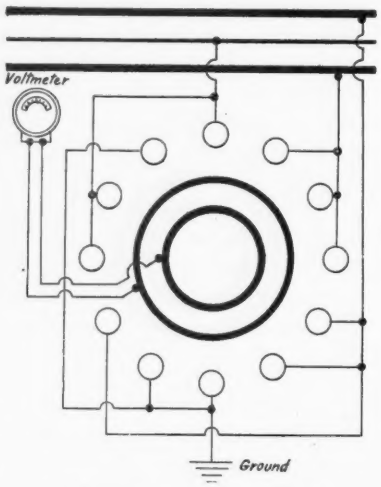
Of course, in case the engine were required to run continually for a week or more it would be necessary to cut oil grooves in the governor, but when the engine is shut down each day this will not be required.

East Pepperell, Mass. J. A.

A Voltmeter Transfer Switch.

EDITOR THE PRACTICAL ENGINEER:

The accompanying sketch shows the proper method of connecting up a voltmeter transfer switch on a three-wire installation in order to obtain all the necessary readings of the line voltage, together with voltage readings between any bus-bar and the earth for making insulation tests.



Voltmeter Transfer Switch

The switch is of the type having two independent points of contact, placed diametrically oppositie on the outer circle, for each of the two points between which it is desired to take a reading; and, as will be seen, the voltmeter will be independent of all other connections. The number of contacts for which the switch may be arranged is only limited by the amount of available space, at the rear of the switchboard, in which to mount it. It is evident one voltmeter can be made to answer every purpose for which several voltmeters, with permanent connections, could be used with the additional advantage of eliminating the amount of error that may exist between the several instruments, which is very desirable in making comparative readings.

The contacts are made by an insulated bar revolving about the center bringing any of the two points of contact desired in connection with one of the rings to which the voltmeter leads is connected and the other point of contact will connect with the remaining ring completing the circuit.

Any engineer can, with very little trouble, make one of these switches, as I did in this case, and at the same time use his favorite voltmeter independent of all other connections. This switch, which I now have in service, handles the polarity correctly for every change on a set of 240 and 120 volt bus-bars.

Baltimore, Md. C. E. SMITH.

Sanding a Large Commutator.

EDITOR THE PRACTICAL ENGINEER:

The following is a description of the trouble and repairs on commutator of a 1,000 K. W. generator, which I think will interest the readers of THE PRACTICAL ENGINEER. In my experience I find that all electrical troubles are simply mechanical troubles, and that the reading of methods employed by others, in overcoming them, is very helpful.

The size of a unit frequently makes quite an impression on the average engineer. I recall leaving a one hundred horse-power plant where I did my own firing, some years ago, to accept a position as second engineer in a pumping station where they had three large, triple-expansion, vertical pumping engines of 15,000,000 gallons capacity. The distance from the engine-room floor to the top deck of these engines was 15 feet, and I was considerably awed by their size until I reflected that the principle was the same in all pumps, and that

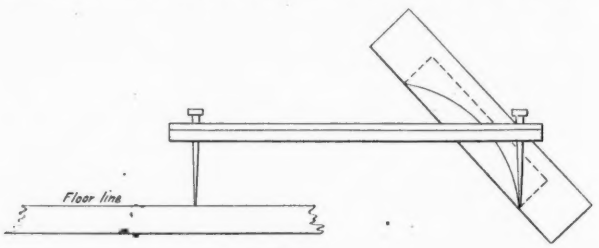


Fig 1

it requires just as much knowledge to operate a small pump scientifically as it does a modern 30,000,000-gallon pump. Some time later I had the opportunity to observe the truth of this.

I was called into a plant where they had a 1,000 K. W. generator, which had been causing considerable difficulty by sparking at the brushes. Upon examination I found the brushes to be made of very soft carbon, causing a deposit on the commutator. The mica insulation between the segments was higher than it should be, and, in fact, all indications seemed to point to the need of a good sanding. Now, sanding

on a small machine is a very simple matter, but for large units more elaborate preparations must be made. In this case we secured a number of soft pine boards, and with a tram, the points of which were set to one-half the diameter of the commutator circumference, as shown in Fig. 1, marked out a number of boards, which were cut so that the inside, or curved surface, would exactly fit a portion of the surface of the com-

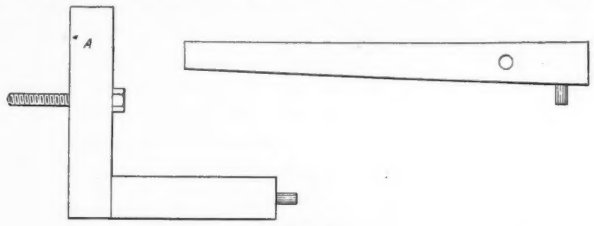


Fig. 2

mutator. These strips were then fastened together by screws, which were counter-sunk until the desired width was obtained. A number of strips of sand-paper were then cut to the size of the block and fastened to it, so that a strip could be easily removed when worn out. A lever and fulcrum were made to hold the block on the commutator, as shown in Fig. 2. The part A is bolted to the frame, a brush-holder being removed for that purpose. A is then bolted in its place and serves as a fulcrum for the lever, the end of which engages in the block, which has a hole in it to receive the iron pin on the lever. In this manner the sanding block is held firmly against the commutator while the engine is allowed to run slowly. Much depends, however, in having the block cut to an exact fit of the commutator.

The management had thought of turning off a portion of the commutator, as they considered it out of true. This was found to be unnecessary after the sanding, which was accomplished with but very little loss of copper.

Columbus, Ohio. M. B.

Stopping the Sparking of a Rotary Converter. Lost Motion of Pump Valves.

EDITOR THE PRACTICAL ENGINEER:

The following is an account of how I stopped a rotary converter from arcing, which I trust may prove interesting to some of the many readers of THE PRACTICAL ENGINEER.

A rotary converter that I operated arced and made so much noise that it had to be sand-papered about twice every week, although we used a special grade of carbon brush. As an experiment I took an extra set of brushes, put them in a can of valve oil, and set the can on top of the boiler and kept it hot for two weeks. Then I put them on the machine, and did not have to touch them for nearly a month, except to use a very little oil on a cloth on a commutator. I had used oil previous to doing this but with poor results. Now I let one set of brushes soak in the valve oil till they are needed and then make the change. This idea I think would benefit any commutator.

Some time ago the rocker arm on one side of our feed pump was broken and as there were no new ones on hand we repaired it by shrinking a band around it. When I put in the new arm I decided to put in a new link and valve-stem as they were somewhat worn. The new valve-stem had a set of jam nuts on either side of the valve and I gave it the same amount of "lost motion" as the old one which worked all right. However, while doing this the following two questions presented themselves to me: (1) Why is a pump valve given "lost motion?" (2) How much should it have and how would one proceed to find the required amount?

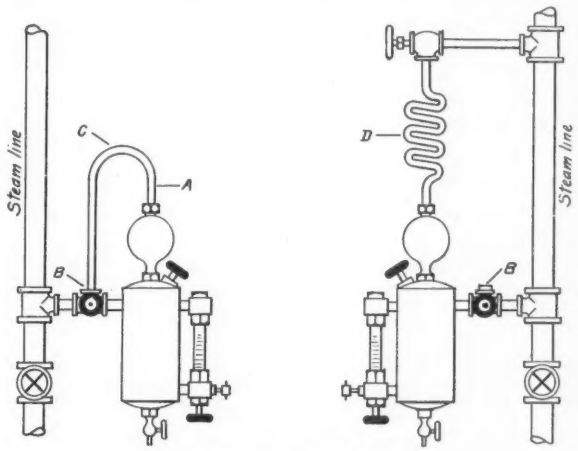
These questions have been discussed by all the engineers and machinists in our plant and each one has a different idea, so that I would like to see them discussed in these columns.

Elyria, Ohio. J. C. H.

Remedy for Lubricator Trouble.

EDITOR THE PRACTICAL ENGINEER:

I experienced considerable difficulty with my lubricator at my last place of employment and, after thinking the matter over, I decided to make a change in the working of the lubricator. Previous to making the change the lubricator remained hot constantly, and when I would think it empty, upon examination I would find it nearly two-thirds full.



Remedy for Lubricator Trouble

By referring to Fig. 1 it will be seen that the change was made at A by removing the brass tube and brazing the union on the valve B. The small piece of bent brass tube C was replaced by a spiral coil shown at D, Fig. 2, which was connected to the main line by a small angle valve.

The results obtained could not have been more satisfactory had I purchased a new lubricator, and should any of my brother engineers experience the same difficulty with their lubricators, I think it would be well worth their while to try this remedy. W. H. R.

Montreal, Canada.

Boiler Connection To Main. Emergency Repair of Boiler Tube.

EDITOR THE PRACTICAL ENGINEER:

The accompanying illustration shows the method I used in connecting up boilers, which may be interesting and useful to some of the readers of THE PRACTICAL ENGINEER.

I have charge of eight boilers, and on each boiler there are three outlets requiring three valves, and on these outlets, between the mains and the valves over the boiler, there were no

less than three flanges on each line. When it became necessary to lay off one or more boilers for repairs, the pipes above the valves would fill up with water, causing the joints to leak and allow the water to drip down on the boilers. As a remedy for this difficulty I had by-passes placed in each line, but this occasioned repairing from time to time of the valves in

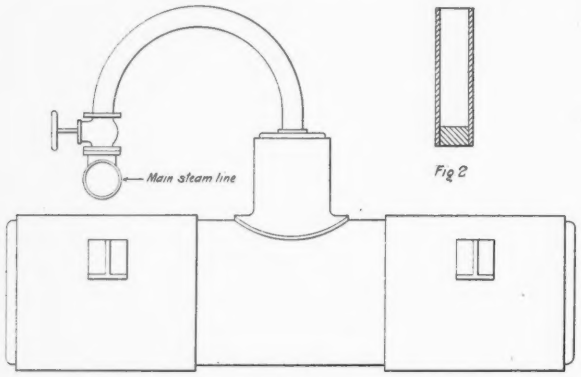


Fig 1
Boiler Connection to Main

these by-passes. I then made the change as shown in Fig. 1, and it has proved more than satisfactory, as there is no longer any place for condensation, and at the same time effects quite a saving in both fuel and repair bills. Should the main line be very high up, a walk may be built along the line by extending hangers down from the roof of the boiler house, and an angle valve and an ell may be used just as well as the curved pipe.

One day a few of my boiler tubes gave out, and, being short of Stirling tubes, I found myself in a serious difficulty, as I could not spare the boiler. As an emergency, I cut a few pieces from one of the old tubes, two feet in length, and welded an iron plug in one end, Fig. 2, and set them in the boiler with the plug end down and rolled them out. The boiler was started and ran for three weeks with this temporary repair until new tubes were received.

A piece of tube with a plug welded in one end will work O. K. in any boiler, and I would advise anyone who finds himself stuck for the want of a tube to give this idea a trial. G. O. B.

South Bethlehem, Pa.

Importance of Graphite Around a Power Plant.

EDITOR THE PRACTICAL ENGINEER:

I have met a great many engineers who do not seem to realize the importance of graphite as a lubricant around the power plant. In my plant graphite is considered to be of as great importance as oil. I have a can in which I mix one part graphite and three parts valve oil, and in replacing the manhole and handhole plates, after washing the boilers, the gaskets are painted with it. This makes a tight joint and a gasket will last a long time when painted with this mixture.

At one time we had considerable difficulty in getting the packing to hold on the plungers of our outside packed feed pumps, when pumping against a pressure of 150 pounds steam, with water at 208° F. The square flax we were using, would get hard and had to be screwed very tight to hold, causing excessive friction, and would only last a few days, although the plugers were in good shape. I bought some sectional rings of standard steam packing and put them in with a liberal supply of graphite and oil, and our packing trouble with the plungers was ended. The valve-stems, rods and plungers on the pumps, and the valve stems and rods on the engine are swabbed three or four times a day with the graphite and valve oil mixture, and they have that glossy finish that all engineers like to see.

Graphite is also a benefit to scored rods as it helps to fill up the scores, and lubricate the packing, thus making it wear longer. As often as convenient the cylinder heads on my engines are removed and the walls given a coat of graphite and oil. The valve-seats, wrist and crank pins and main bearings also get their share and I have found the graphite and oil especially beneficial when used on warm bearings. In the making of pipe joints it will be found to be better than lead, as it does not cause the gasket to stick, but will make a steam-tight joint.

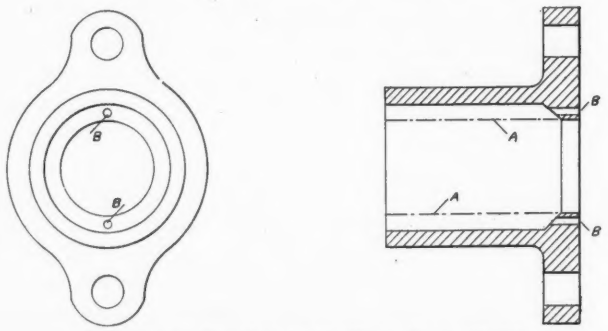
Care should be exercised not to use too much of the graphite at a time, as it will bake and fill the oil grooves on the bearings; but if used with oil it will not do this but will fill in the small holes and form a good bearing.

Elyria, Ohio. J. C. H.

Scheme for Keeping Valve Stem Stuffing Boxes Tight.

EDITOR THE PRACTICAL ENGINEER:

I used to have considerable trouble with a pair of Corliss engines that have been running 35 years, but which are doing good work at present, because the valve-stem stuffing boxes would blow steam. As the boxes were only about 1¾" in depth and the valve stems were made of brass, if the glands were screwed up hard, the valve stems would become scored, making matters worse, so that the only thing to do was to renew the packing often. So I thought I would experiment by taking one of the valve-stem stuffing-box glands and boring it out, so that I could use a smaller size packing in the gland than



Scheme for Keeping Valve-Stem Boxes Tight

was used in the stuffing box, and at the same time I would make the actual depth of packing 3¾ inches, where it was 1¾ inches before. This worked so well that I concluded to bore out the other seven glands.

The results obtained are very satisfactory, as I now have tight stuffing-boxes where they used to show steam-blowing before. They now just show a small leakage of water, and the packings last longer, as well as the valve stems. This

style of box requires two sizes of packings, but I think that any extra labor spent in packing those boxes more than repays itself for the longer life of the packing and valve stem.

If any engineer thinks that it would be considerable bother to get the packing out of the glands, if he will bore a 3/16" hole on each side of the box close to the valve stem and use a piece of brass wire, he can drive all the packing out of the gland in short order, when he wants to repack the gland. In the accompanying sketch, the dotted lines AA show the original diameter of the metal, and the holes BB show where to bore the 3/16" holes. Just what amount to increase the diameter and what sizes to bore the holes will, of course, depend on the size of the stuffing-box gland, and the engineer should use his own judgment about that.

Fall River, Mass. M. H. H.

Difficulties of Operating Compound Generators in Parallel.

EDITOR THE PRACTICAL ENGINEER:

Replying to C. E. N.'s question in the June issue, as to why one of his generators does not compound, it seems to me it would be rather a difficult matter to keep the generators in parallel on a street car service load that varies from zero to 500 amperes, if one compounded and the other did not.

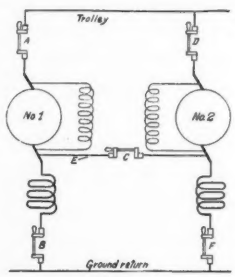


Fig. 1

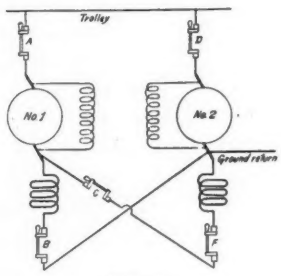


Fig. 2

It would be my opinion that when they were working together they would be operating as shunt-wound generators, or that they both compounded to a certain extent; although, when working singly, one would compound and the other act as a shunt-wound machine. With this idea in view I will endeavor to explain how the above conditions may be brought about, which may be more clearly understood by referring to the accompanying diagrams. The armatures, series windings and equalizer connections are shown in Figs. 1 and 2. The shunt windings are also shown but they do not affect the actions of the machines; A, B, C, D and F represent the switches and E the equalizer, in both diagrams.

Referring to Fig. 1, should a substantial ground occur anywhere along the equalizer E, with A, B and C open and D and F closed, generator No. 2 would not compound on account of the series winding being short-circuited. If C, D and F were open and A and B closed, generator No. 1 would compound, but if all the switches were closed neither machine would compound, as both series windings would be short-circuited by the ground at G.

Fig. 2 shows the equalizer and one generator lead transposed, which is hardly probable, although it might be possible. With A, B and C open and D closed (the position of F would make no difference), generator No. 2 would not compound on account of the ground return being connected to the brush side of the series winding. With A and B closed and C and D open, generator No. 1 would compound, and with all switches closed both generators would compound to a certain extent as both series windings would be in parallel to each other and in series with generator No. 1 and the ground return.

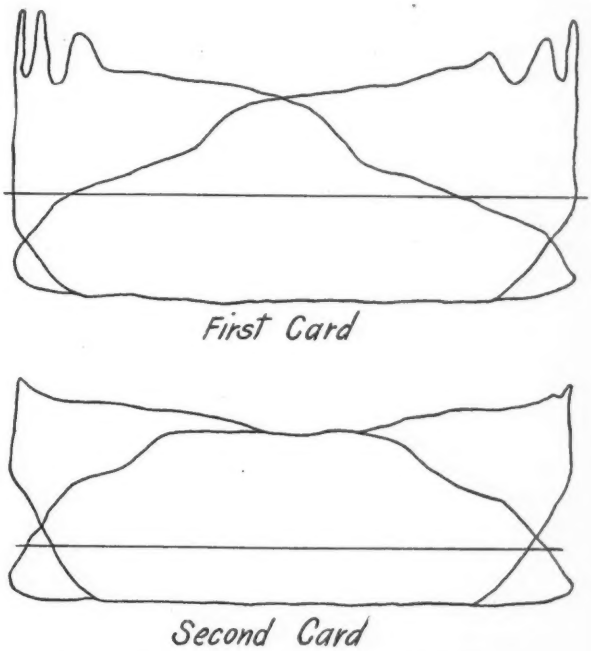
It would be necessary, however, in the above case, for the connection to be such that the current passing through the series winding of generator No. 2 would aid the shunt winding.

Indianapolis, Ind. G. E. R.

Reducing Vacuum Changes Pounding Engine Into a Smooth Running One.

EDITOR THE PRACTICAL ENGINEER:

I am night engineer at a plant using a Fitchburg 200 horse power, compound, condensing engine, high pressure cylinder 13 inches, low pressure cylinder 24 inches, stroke 24 inches, and running 132 revolutions per minute. The high pressure side exhausts into a receiver from which the low side takes its steam. The low pressure side pounds badly and I would like to know where the trouble with this engine is, and how to remedy it. The first card was taken from the low pressure cylinder with a receiver pressure of 14 pounds, vacuum 25 inches, under which condition the engine pounds to beat the band. The second card was taken with the condenser valve partially closed, the receiver pressure running up to 18 pounds. Under this condition, the engine runs nice and still, and slick as a whistle. Can any reader tell me why reducing the vacuum remedies the pound?



Reducing Vacuum Produced a Better Card and Stopped Pounding

W. Groton, Mass. C. N. L.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Answers to J. B. L.'s Questions.

EDITOR THE PRACTICAL ENGINEER:

The following answers will inform J. B. L. as to the exact conditions under which the boilers in my plant gave such a good evaporation, which both he and I think unusual:

1. What is the working pressure on these boilers which he mentions? *Ans.* One hundred pounds gauge pressure.

2. How much coal do they burn per hour, and what kind of coal? *Ans.* Fuel is shavings and saw dust used with self-feeders.

3. What is the temperature of the feed water, and how is it heated? *Ans.* Water is pumped from open heater through a closed heater and averages 212 degrees.

4. Have the steam lines to the engines separators in them? *Ans.* No.

5. Is all the condensation returned to the boilers, and, if so, how? *Ans.* Most of the condensation is returned. It flows to the open heater, from which it is pumped through a closed heater to the boiler. M. T. M.

Winooski, Vt.

Recharging Dry Batteries.

EDITOR THE PRACTICAL ENGINEER:

I would like to know how to recharge dry cell batteries. Please reply in your next issue.

Lacrosse, Wis. C. A. J.

It would probably be cheaper to buy one of the many makes of dry cells on the market than to attempt to recharge the old battery. If, however, it is desirable to recharge them, all the interior of the old batteries should be taken out and the zinc cup cleaned. Next make the solution, which is done by dissolving five ounces of sal-ammoniac in one pint of clear water. When so dissolved, add seven ounces of granulated chloride of zinc, and stir until dissolved, continuing the stirring every few minutes for an hour or more. The solution is then ready for use.

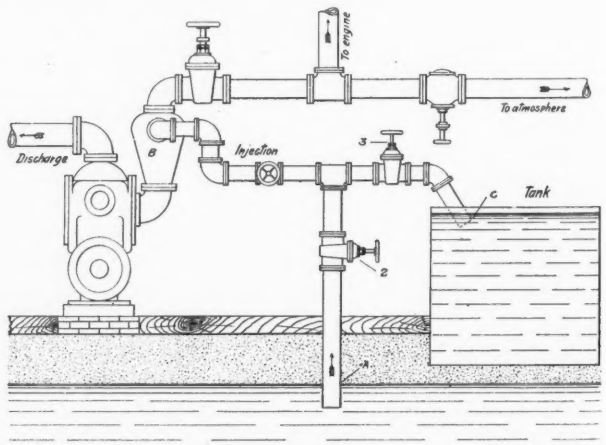
The negative or carbon element is made by mixing eight ounces of powdered black oxide of manganese and sixteen ounces of powdered carbon thoroughly together and moisten with five fluid ounces of the solution. If the carbon and manganese are very dry, a little more solution may be needed.

Before filling the interior of the zinc cup, it must be lined with several layers of blotting paper, about three or four turns, which must fit tight. Then soak the blotting paper inside the zinc cup thoroughly with the solution; fill the cup three-quarters full and let it stand several minutes; then pour out the solution, place the carbon plate in the center of the zinc cup and pack in the carbon element good and hard. This may probably force a little of the solution up the paper by compression, but this will not injure the cell any. When the powdered elements are wet enough, clean away all the particles of the carbon element from the top of the paper and zinc cup so that there will not be any internal short circuit. Seal the cell, allowing the zinc and carbon connectors to protude and the cell is ready for use again.

Further Information Wanted About Condenser Problem.

EDITOR THE PRACTICAL ENGINEER:

I was somewhat disappointed when I read the answers to my question, "Will the condenser pump use more steam when lifting water 12 feet than when the water runs to the pump," as it appeared in your valuable paper. M. H. H. suggested that I put a gauge close to the condenser, and then if I make a change, I can prove for myself whether the change effects the gauge reading or not. For the benefit of M. H. H., I would say that I already know that the change won't affect the reading of the gauge, but I have about a dozen first and second-class engineers, including my chief, to prove it to before making the change, so that this suggestion will not help me any. Then comes A. J. C. stating that my suggestion is correct, and he tells me how to save two 45-degree ells, and that then I can get plenty of water. In his opinion, the steam consumption will remain the same, which is all very comforting to me, but fails to throw any light on the subject. Then comes E. T. R., who



Which Method of Supplying the Condenser is Preferable?

thinks it can be changed, and, in his opinion, no extra steam will be used no matter what the lift may be, providing it is not too much for the pump.

Now all the engineers in this locality who claim that my suggestion is wrong are readers of THE PRACTICAL ENGINEER. I was going to say subscribers, but they are not, because some of them practice economy, and borrow instead of buying the paper. Mr. Editor, it is wonderful how they know on which day the paper gets here. Two hours after the

paper arrives, a helper, or ash or coal wheeler will be over with a note from their chief to find out if I have got through with THE PRACTICAL ENGINEER. Anyhow, they all read it, and when they saw the answers to my question in the July number, they laughed at the proof I could furnish in reference to the steam consumption remaining the same.

The accompanying illustration represents a sketch that I submitted to them in support of my suggestion. I claimed that the pressure at A was about 15 pounds absolute, and when the pump was carrying 25 inches of vacuum, the pressure at B was about 2½ pounds, and that the suction pipe of the pump would remain full of water when valve 2 was opened, and valve 3 closed, or vica versa, and with the pump carrying 25 inches of vacuum, a gauge put on the vertical pipe at A would show no pressure either above or below the atmosphere. It would be just atmospheric pressure and no more. The same condition would prevail if a gauge was put on at C. Then if valve 2 was closed the water would remain in the vertical pipe above it, whether the pump was carrying a vacuum or not, which shows that the pump expends no power to lift the water, but only to create the vacuum. The power necessary to run a condensing pump is due to the pressure on the suction valves, and the power necessary to run a force pump is due to the pressure on the discharge valves alone.

Now if some of my brother engineers would only give me some data to prove that my suggestion was right, I would be thankful. I know the editor will allow them a little more space, as I am looking for information, and there are others in the profession that need it as bad as I do.

Pittsfield, Mass. T. S.

New Jersey City License Law.

EDITOR THE PRACTICAL ENGINEER:

Will you please tell me how the new Jersey City license law will affect engineers and also owners of the plant?

Jersey City, N. J. M. T. M.

This question can best be answered by printing the Jersey City license law in full. This law went into operation July 2, 1907, and is as follows:

Section 1. No person shall operate any boiler used for the purpose of generating steam within the corporate limits of Jersey City (except for railroad locomotives, engines, private dwelling, or on vessels running under the jurisdiction of the United States Board of Supervising Inspectors) unless he be twenty-one years of age and a citizen of the United States, and shall have been duly examined and licensed for that purpose as required by this ordinance; nor shall any person or persons or corporation employ anyone to operate such steam boiler within said city who is not duly licensed as aforesaid.

Section 2. The Board of Aldermen of Jersey City shall appoint three competent and licensed engineers, two who shall have had at least ten years' experience, for a term of one, two and three years respectively, and one every year threafter, who shall serve for a term of three years or until his successor shall be appointed, who shall examine all applicants for license to operate steam boilers and to issue licenses to such as shall be found qualified. Each of said examiners appointed shall be paid a compensation at the rate of one hundred dollars per annum, payable quarterly, but in no event shall the aggregate amount of such compensation exceed at any time the aggregate amount of money received for said license by the City Treasurer under the provision of this ordinance.

An examiner absenting himself from three successive meetings may be removed by the Board of Aldermen.

Section 3. All applications for examinations hereunder shall be made to the City Clerk, in writing, and must state the location and capacity of the boiler plant the applicant intends to operate; the name of two respectable citizens as to the temperate habits and good character of the applicant, and be signed with the full name of said applicant.

Section 4. The said examining board shall hold meetings for the purpose of examining applicants whenever they may deem advisable. Meetings must be held at least semi-monthly. Two examiners shall constitute a quorum for the transaction of business, and shall have power to make and enforce such rules and regulations, not inconsistent herewith, as shall be necessary for the proper conduction of such examinations of applicants.

In case any applicant, upon his first examination, shall fail to satisfy the examiners of his ability to operate the boiler plant mentoined in his application, a temporary permit may be granted to him to operate said plant for a period not exceeding thirty days, at which time the applicant must again present himself for examination.

Such temporary permit shall not be granted more than once to the same person.

The examiners shall keep a suitable record of the proceedings, including the name and address of all applicants and the results of all examinations, and make report from time to time to the Board of Aldermen.

Section 5. Every person who shall be found, on examination by said examiners, to be qualified shall receive a license to operate the boiler specified in their application for one year, which license shall be signed by said examiners or majority thereof, and countersigned by the Mayor and City Clerk, upon the payment of the sum of two dollars to the City Clerk. For the annual renewal of said license a fee of two dollars shall be paid as above.

Section 6. If any person duly licensed as above shall take charge of a boiler plant different from the one specified in his license he shall notify the City Clerk of such change and present himself for a transfer. And may be required to undergo another examination if so decided by the Board of Examiners, and if found qualified, shall be entitled to and receive a license for the unexpired term for which the original license was issued without any further cost.

Section 7. Every license granted as above shall be displayed conspicuously in the boiler room or engine room where the person so licensed is employed.

Section 8. Any license issued under the terms of this ordinance may be revoked or suspended if charges be preferred by a vote of a majority of the members of the Board of Aldermen present at a meeting and voting thereon.

Section 9. Any violation of this ordinance shall be punishable by a fine of not less than ten dollars nor more than one hundred dollars.

Section 10. The Board of Examiners shall issue licenses

of the following classes: First, Second, Third and Fourth. First class engineer's license giving authority to have charge and operate any steam boiler or engine and require at least three years' experience. Second class engineer's license to have charge and operate any boiler or engine not exceeding three hundred (300) horse power. Third class engineer's license to have charge and operate any boiler or engine not exceeding seventy-five (75) horse power. Fourth class, a special license to operate a particular plant and no other, and is issued only on written request of the owner of said plant to be filed with the application for examination.

Section 11. After an applicant's examination he shall be graded according to his standing and without regard to the grade of license applied for.

Section 12. Any engineer in charge of any engine who shall abandon the same while in operation without leaving a proper person in charge thereof in the opinion of the owner or employer of such engineers shall be fined, on conviction, a sum of not more than twenty dollars nor less than five dollars.

Section 13. The words "have charge" in this ordinance shall be construed to designate the person under whose supervision a boiler or engine is operated.

Section 14. The Board of Examining Engineers shall have power to inspect all boiler plants for the purpose of seeing that the provisions of this ordinance are properly carried out.

Section 15. All acts or parts of acts contrary to the provisions of this ordinance is hereby repealed.

Centre of Gravity of Fly-Wheel. Vacuum Chamber of Pump.

EDITOR THE PRACTICAL ENGINEER:

Kindly answer the following questions:

Will there be any more weight on the bearings of a fly-wheel when running than when standing still, and does the centre of gravity of the wheel change?

What is meant by the vacuum chamber of a pump?

Northampton, Mass. F. A. G.

If the fly-wheel is properly balanced there will not be any more weight on the bearings when revolving than when stopped. The centre of gravity does not change in the fly-wheel that is revolving, because the centre of gravity is at the centre of rotation.

A vacuum chamber is put on the pump to facilitate the changing of the flow of water into the pump from the intermittent to the continuous flow. The moving columns of water compress the air in the vacuum chamber at the end of the strokes of the piston, and when the piston starts, the air expands and aids the piston in setting the columns of water in motion again. The flow of water in the suction chamber of the pump is therefore more uniform during each stroke of the pump than without the vacuum chamber, and consequently the pump can be run at higher speeds without increasing the loss, due to slippage, or without becoming noisy.

Maple Syrup vs. Cylinder Oil.

A story is going the rounds that is proving very amusing to the wise ones who know all about automobiles. It wouldn't have happened if his name had been an unusual one; but his name is Smith, and he lives in a small town in Vermont.

He owns an automobile that he purchased from Charley Fay, manager of the Boston branch of the company. The car had been running fine for several months, and Smith had written several times to say how delighted he was. But one day there came a change, in the form of a letter that detailed all the ills a motor car is heir to, and winding up with a request for immediate information as to what to do to make the motor perform as of yore. Fay diagnosed the case as well as he could, and sent him a bunch of "absent treatment" by return mail. But it was of no use. A telegram stated all the expedients suggested had been tried, but the motor would not "mote." Fay wired for more symptoms. In reply he would receive information that the engine, after much cranking would start, run for a few seconds, smoke, spit and emit a terrible stench. "Seems as if it is running hot," ended the telegram. Fay suggested examining the pump, commutator, carburetor, coil, and everything else he could think of, and concluded by advising, "put plenty of oil on the engine base." Smith replied, "Nothing doing."

Then Fay got him on the telephone.

"What kind of cylinder oil are you using?"

"Same as you sent me last week," replied Smith, hotly.

"That's good cylinder oil," said Fay, "but I cannot understand the engine heating—put in some more oil."

"Got the case half full now," yelled back Smith.

"Well, put in some more," replied Fay, as he slammed the receiver back on the hook.

In half an hour a telegram told Fay he could send an expert to make the car run or take back his old machine.

It was in the middle of the selling season. Runabouts were going at the rate of ten a day and every competent man was required to tune up the new ones. But there was no way out of it; a man must be sent.

"Half a day to go, half an hour to make the engine run, and another half day to return," growled Fay—"wish that fellow could think of one symptom he didn't tell me, so I could tell him what ails his car."

Man was absent three days. When he returned, he met the infuriated manager, who asked, "What on earth kept you so long—what have you been doing?"

"Took his engine all apart, cleaned it, and put it back in."

"Why, what was wrong with it?"

"This," said the man, setting a can of light brown liquid before his chief.

"That looks like good cylinder oil," said Fay.

"Looks like it, yes—that's the trouble. It's maple syrup."

Strange as it may seem, there are two Smiths in this Vermont town. A friend had shipped a can of maple syrup to one on the same day, and by the same express company that was carrying the can of cylinder oil from Fay to the automobile owner. Cans got mixed on the way. When the expert took the motor apart he found the cylinders full of maple syrup, the bearings full of syrup and the muffler choked with the half-burned wax.

Fay is now wondering how the other Smith relished the cylinder oil on his pancakes.

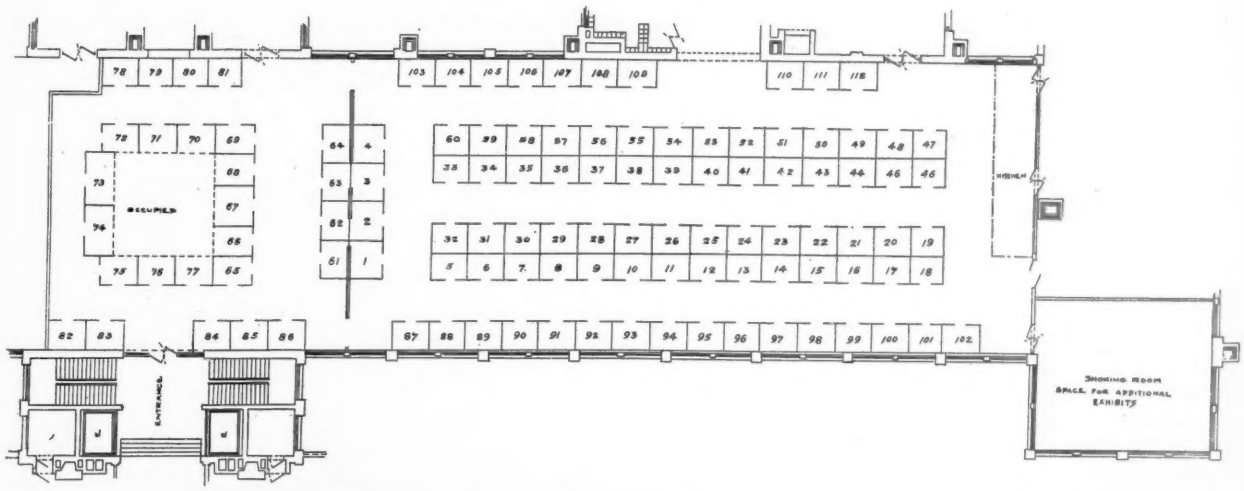
Plans and Arrangements for the Twenty-sixth Annual Convention of the N. A. S. E.

The Twenty-sixth Annual Convention of the National Association of Steam Engineers, which will be held at Niagara Falls, September 9th to 14th, promises to be one of the largest banner conventions ever held by that organization. While it is to be expected that a healthy and growing organization will each year eclipse its convention efforts of former years, yet at the same time the advantages of location and environment often add those things to the success of a convention, which no committee or amount of effort could produce when handicapped by location.

It is therefore with happy hearts and cheerful minds that officer and delegate, committee man and supply man, look forward to the coming of the second week in September, when two thousand or more engineers will meet within the roar of one of the greatest natural wonders of the world—the Falls of Niagara. Not only is this enormous water-fall, with its even more awe-inspiring rapids, noted for its scenic beauty, but there are engineering features all around the town of Niagara Falls, which are almost as wonderful as the falls itself, where the display of engineering supplies will be held, the natural wonders of the falls and its engineering features, no one need go away without having benefited in an educational way.

The exhibit of engine and boiler room equipment will this year far surpass previous efforts, which have been made by the National Exhibitors Association. The large building of the Natural Food Company will be used for the exhibits, and every exhibit will be on the one floor. All booths and decorations will be limited in height and area, so that the general effect of the one hundred and twenty or more exhibits should present a beautiful sight. This year for the first time the General Electric, Westinghouse and other large engine builders will participate in the display. A full line of packings, oils and greases, insulation for pipe covering, valves, injectors, feed water heaters, separators, steam traps, oil filters, indicators, pumps, safety-valves, exhaust heads, boiler skimmers, damper regulators, lubricators, gauges, feed-water regulators, boiler compounds, grates and other steam specialties will be shown.

The officers of the National Exhibitors Association, who have charge of the exhibits and the entertainment of the dele-



Plans of the Exhibition Hall, National Food Co. Bldg., 26th Annual N. A. S. E. Convention, Niagara Falls, Sept. 9th to 14th

and perhaps even more so, because they represent what to-day is the most advanced application of the harnessing of natural forces and the use of the electric current. While Niagara Falls has existed for centuries, the generation and distribution of electric current from this great water center has only taken place within the last dozen years, and it is now the mecca of egineers who wish to study all the various phases of the high voltage transmission of power.

To the average visitor, so subtle is the means by which the power of the falls is absorbed that hardly any signs of the actual machinery is visible, which go to make it the great energy center which it has become, unless it is the threadlike wires, which silently radiate in all directions and which are held in place by the heavy porcelain insulators mounted on steel towers.

To the engineer, however, there are days of investigation and education in the power houses, sub-stations and electrical industries around the falls, so that between the exhibit hall, gates and visitors, are: President, John A. Carson, of A. W. Chesterton & Co.; Vice-President, J. L. McGilray, of the Peerless Rubber Co.; Secretary, C. K. Thomas, of the D. T. Williams Valve Co.; Treasurer, Geo. D. B. Van Tassel, of the Westinghouse Machine Co.; Executive Committee: F. A. Morrison, of the Mason Regulator Co.; H. S. Demarest, of Greene, Tweed & Co., and W. D. Purcell, of the Quaker City Rubber Co.

The entertainment of the delegates and visitors is as follows: Monday, September 9th, Grand Opening Reception in the evening at the Cataract House. Tuesday, September 10th, automobile ride for ladies, opening of convention in the morning; in the afternoon, opening of the exhibition and business session of the convention; in the evening, informal dance and special evening for the ladies in the exhibition hall. Wednesday, September 11th, trip to Toronto, by way of the Rapids. Entertainment at dinner at Toronto by Canadian engineers. Luncheon on boat during return trip, reaching Niagara Falls

in the evening, by searchlight up the Gorge. Thursday, September 12th, vaudeville performance at the theatre. Friday, September 13th, ladies to visit various points of interest, delegates to visit the power plants. The Grand Ball at night at the Cataract House.

Throughout all this pleasure there is a vast amount of work laid out for the delegates, as there are a number of important matters coming up before the convention this year, which will take serious consideration and give the orators of the convention a chance to show their elocutionary powers. The matter of settling a place for the next convention will be decided at one of the week's end sessions. Already, Denver, Colorado, and Seattle, Washington, are making strenuous efforts to capture the convention for 1907, and a number of other cities will launch their booms when the delegates arrive at the convention.

The city of Niagara Falls has thrown its doors wide open to the visiting engineers and the local committee of engineers consisting of H. J. Humphries, W. H. Aydelotte, John McSpadden, W. C. Marlow, Chas. A, Baker, H. A. Campaigne and Peter McGarigle have perfected hotel arrangements and other local details for the comfort and convenience of the visitors who will flock to their doors.

Coincident with the week of the convention there will be an elaborate display of searchlights on the Falls. The General Electric Company are going to make a number of experiments with powerful searchlights, the largest of which is sixty inches in diameter. If the experiments prove successful, it is expected that the city of Niagara will purchase the searchlights to be used permanently for illuminating the Falls.

Dallett Automatic Hose Couplings.

The remarkable development during the last few years in the application of compressed air in various industries has had the effect of stimulating the ingenuity of manufacturers of fittings used in connection with pneumatic tools, especially hose couplings.

The Dallett Hose Coupling, shown in the accompanying illustration, is the result of a continuous series of experiments and tests made on hose couplings for the past four years. It is strong in construction, its life is long and it will stay tight under all conditions. The cut shows the two halves of a Dallett hose-to-hose coupling and the gasket used. The gasket is made of rubber composition, which will not be affected by oil or gasoline, and is held in the female half of the coupling by a flange around the larger end fitting into recess. This gasket cannot fall out or be lost when the coupling is disconnected and, when necessary, a new gasket can be inserted in a few seconds.

When the coupling is connected the tapering end of the gasket enters into the conical opening in the male part and is a loose fit therein. When pressure comes on the coupling this tapered end of the gasket is expanded against the wall of the conical opening, making a perfect joint, which the greatest pressure will only make tighter, and as soon as the pressure is relieved the gasket is again loose. It is claimed that with this arrangement no matter how long a coupling may remain connected it will not adhere to the metal and will not be torn and ruined when the coupling is taken apart.

The male part of the coupling is provided with four locking-lugs, equally spaced around its circumference, and when the male and female parts are snapped together, these lugs insure their being held squarely, which obviates any tendency to leak.

To connect the coupling, press the parts together, give one-eighth of a turn and the locking-ring will spring into place. It is then impossible for it to be pulled apart or accidentally disconnected. When the connection is to be broken, press back the locking-ring and give the coupling one-eighth turn.

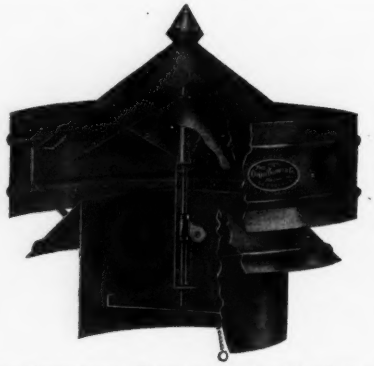
The Dallet Automatic Hose Coupling

The entire coupling is made of bronze composition, has no small parts to give trouble, and no proejcting pieces to catch when the hose is trailed along the ground. The locking-ring is provided with a milled ridge around its circumference which affords a grip for pressing it back when disconnecting the coupling and so stiffens and strengthens it that it requires abuse to spring or bend it so as to impair the working of the coupling.

The Dallett Coupling is made by the Thos. H. Dallett Co., 23d and York Streets, Philadelphia, Pa., who will furnish other information desired.

The Swartwout Gravity Closing Ventilator.

When using a ventilator it is very often desirable to have it close, so that it will be weather proof. It is also desirable, when it is opened again, that no dust or dirt shall fall back into the building, or the value of the closing mechanism will be lost. The Swartwout Gravity Closing Ventilator shown in the accompanying illustration fulfills these conditions.



The Swartwout Gravity Closing Ventilator

The damper is mounted upon a heavy iron sleeve which slides up and down on a rod, thus preventing catching or binding. It closes by gravity and is raised by means of a chain passing over a specially made cast iron pulley, the housing of which is secured to the rod guiding the damper. When the damper is shut this pulley and the working parts are enclosed and protected from the weather.

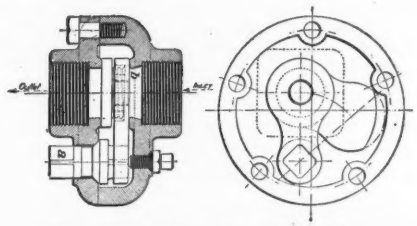
The damper is conical in shape and overhangs the edge of the flue, which prevents any dust from shaking and re-entering

the building, when it is opened, and which makes it weather proof when closed. The ventilators are made in various sizes and are furnished with a special chain for working the damper. The Ohio Blower Co., of Cleveland, Ohio, are the manufacturers.

The Everlasting Blow-Off Valve.

Owing to its location at the lowest and coolest part of a boiler the blow-off valve must stand the severest kind of service, as solid matter, mud and precipitated salts will gather near it, so that when the valve is opened with pressure on the boiler a rapid rush of hot water will force these impurities through the valve.

A valve, which has been designed for this particular service, is known as the Everlasting Blow-Off Valve, and is shown in the accompanying illustration. When opened, it has a straight and uninterrupted blow of uniform section from end to end, so as to eliminate the danger of arresting particles of sediment, thus making positive the discharge of scale, sediment and other matter, and as the valve disc never leaves the plane of the seat, it prevents the lodgment of any foreign particles upon the seat and ensures steam tightness upon closing. Should the seat, after long service, become scarred or corroded, it may be redressed by the use of a fine file or a scraper, the valve being so designed as to expose this face upon removal of the bottom bonnet.



The Everlasting Blow-Off Valve

The valve is composed of two saucer shaped bonnets, set together upon a high-pressure gasket with tap bolts. Upon the lower bonnet is cut the valve face, upon which the valve slides. The valve is actuated by square-headed post, to which the crank-arm is attached. The seat in the lower bonnet is raised above the plane of the joint, the valve sliding upon it, thus wiping it clean at each operation and eliminating the chance of any part of the deposit from the discharge being interposed between the steam-tight surfaces when the valve is closed.

The valve at all times is pressed against the seat by the boiler pressure, which not only aids in keeping it tight, but which allows of repairs and re-surfacing, should the surfaces become injured in any way. It is lever-operated and so balanced that it is said that an effort of only twenty-five pounds upon an 8-inch lever is required to open and close it against two hundred pounds pressure.

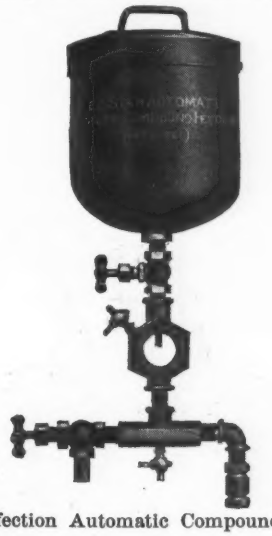
When the valve is open the discharge opening is round and of the same diameter as the discharge pipe, the discharge and inlet nipples being arranged close together, so as to make the discharge passage practically continuous and uninterrupted.

These valves are being used for stationary, marine and locomotive service and are manufactured by the Patterson-Allen Engineering Company, 421 Chestnut Street, Philadelphia.

Red Star Automatic Back Pressure Boiler Compound Feeder.

In all cases where it is necessary to use boiler compounds or chemicals for the removal or prevention of scale, it is desirable, and better results will be obtained, if the compound or other chemicals are delivered to the boiler frequently or in small portions, just sufficient compound being used to soften the water and hold the scale forming matter in suspension. To admit a large quantity of compound at one time is not only wasteful of the compound itself, but it may cause "priming" and possibly harm the products of the factory, which come in direct contact with the steam and which would not be injured by such contact if the chemicals were fed to the boiler with proper regularity and in moderation.

Realizing the advantage of maintaining a constant supply of soft water with the smallest possible amount of chemicals or compound, engineers have invented numerous devices designed to feed compound to the boilers automatically and in just the proportions necessary to maintain satisfactory conditions.



The Perfection Automatic Compound Feeder

A very successful compound feeder, which has met with favor among engineers, is the "Perfection," a cut of which is shown herewith. The marked advantage of this feeder is its sight-feed, which shows the exact amount of compound being fed as it passes drop by drop to the feed water entering the boiler, thus admitting the proper quantity, which is subjected to regulation as required. Another advantage claimed for this feeder is that it will work against any back pressure and always leave the sight-feed chamber free from water, so that the exact feed of compound may be clearly seen.

The tank holds two gallons and is made of heavy pressed steel with cover. It is fitted with a perforated false bottom, which acts as a strainer. The sight-feed is made of cast iron, with brass rings to hold the glasses in place, these being 2 5-16 inches in diameter and ¼ inch thick. The injector tee is made of grey iron with brass nozzles, and the cut shows the feeder ready to be attached to the pump or injector.

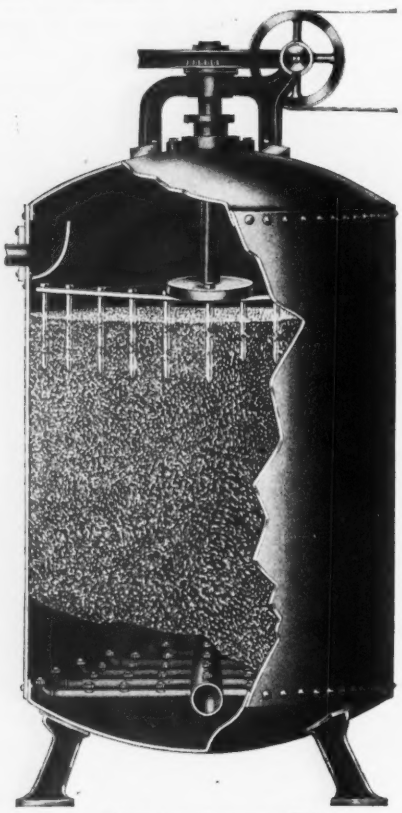
Both sides of the feeder are connected to the boiler feed pump, one connection going to the suction line, and the other to the discharge line. After the feeder is properly set up the valve under the tank is closed, and the tank is

filled with compound sufficiently diluted with water to make it drop freely. The valve under the tank is opened just enough to give a steady drop by drop feed, excepting where it is desired to use the feeder for large boiler capacity, requiring the feeding of a stream of compound, then the valve is opened farther. Open the angle needle valve, which connects on the end of the injector tee, and the feeder is in full operation.

This feeder is made by The Lake Erie Boiler Compound Company, 198 Chicago Street, Buffalo, New York, who lend one free to each user of their Red Star Boiler Compound.

Water Purification by the Keystone Pressure Filter System.

One of the most perplexing problems that confronts the steam user to-day is the solution of the proper method which will effectually and economically keep the boilers free from scale. As all waters are not alike, it will always be a problem for the individual user to decide for himself. There is a growing demand, however, for a filtering system, which not only removes the suspended impurities in the feed water, but which also removes the dissolved scale forming impurities, such as the carbonates and sulphates of lime, magnesia, etc. The Keystone Pressure Filtering System is said to perform these functions efficiently, so that after the boiler feed water passes through it, it is claimed that the boiler will not suffer from priming, scale or corrosion.



The Keystone Pressure Filter

As may be seen from the accompanying cut, the filter consists of a cylindrical steel shell, capable of withstanding pressures up to one hundred fifty pounds per square inch. It stands upright on cast iron legs and contains a deep bed of clean machine quartz, which is crushed and sifted. Quartz is said to be the best material for removing suspended impurities from water, because it is unaffected by chemicals of any kind and lasts indefinitely.

At the top of the filter there is a steel "agitator" operated by a worm gear, by means of which the filtering bed may be thoroughly broken up when desired. In the bottom of the bed of quartz are a considerable number of strainers, arranged to insure a uniform draft on all parts of the bed, so that the work of filtration may be evenly distributed.

Construction of Keystone Strainer

The strainers themselves are non-corrosive bronze, and, as shown in cut, the top is solid, thus enabling the weight above to be easily supported. The openings are vertical in the sides and are of ample total area to permit the free flow of water to the outlet pipes. These latter unite in one central drain, which delivers the purified water to the boiler. In the bottom, beneath the quartz, is a drain cock, by means of which the space below the strainers can be drained. For washing the filter there are several pipe connections not shown in the cut, by which the sediment, foreign matter, etc., can be rapidly removed and carried off into the sewer. These impurities cannot penetrate the quartz bed to any extent, therefore it is easily and thoroughly cleansed during the process of washing out the filter. This requires from fifteen to thirty minutes time each day, when the precipitate is heavy, and, aside from filling the chemical tank, it is all the attention required of an engineer, for the system is practically automatic in operation.

The removal of suspended impurities is easily accomplished by all good filtering systems. It is the removing of the dissolved scale-forming impurities, such as carbonates and sulphites of lime, magnesia, etc., on which the Keystone Pressure Filtering System claims superior merit. No settling tanks are required; the only equipment in addition to the filter is a chemical tank of sufficient size to suit the plant. In this tank is kept a supply of Keystone Tri-Sodium Phosphate, which is used in solution and fed to the water before it enters the filter. This is accomplished by gravity pressure wherever possible.

When open heaters are used the precipitant is fed into the heater with the feed-water, and where closed heaters are used it is fed with the feed-water through the suction of the pump and then through the heater and filter, thus getting a full chemical action before the water enters the filter. The action in all cases is to precipitate the harmful constituents as insoluble phosphates, and these, upon reaching the filter are held up in the same manner as are the suspended materials. In consequence of this double treatment of the water it leaves the filter not only mechanically, but chemically pure, and the makers

guarantee that boilers, in which only this water is used, will not suffer from priming, scale or corrosion.

This system has already been installed by a number of firms throughout the country, including the United States Government at Washington, where it is said to be giving excellent satisfaction. The Keystone Chemical Manufacturing Company of Philadelphia are the manufacturers.

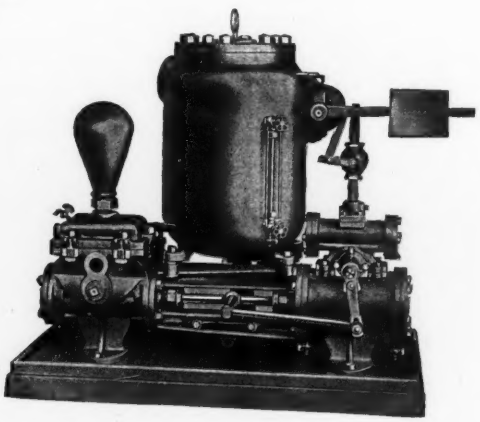
The Davidson Automatic Pump and Receiver.

The combined automatic pump and receiver, illustrated herewith, is of the well-known "Davidson" manufacture, and is a simple and reliable form of apparatus for taking the water of condensation from coils, steam pipes, radiators, etc., and also from separators on main steam lines and automatically returning this water to the boilers.

The water pumped back to the boilers being hot, saves fuel, and the positive operation of the automatic pump avoids the snapping and hammering in pipes which is very prevalent in many return systems.

These receivers and pumps have been installed in power plants taking the drips from separators on steam lines carrying 200 pounds pressure, returning same to the boilers. It is said that water of this high temperature and under this pressure has never been successfully handled by an automatic pump and receiver until the advent of this apparatus.

The action of the lever governing the chronometer valve is positive, and where high temperature and pressure are present no float is used, but by means of an ingenious principle which cannot get out of order, the same result is obtained.

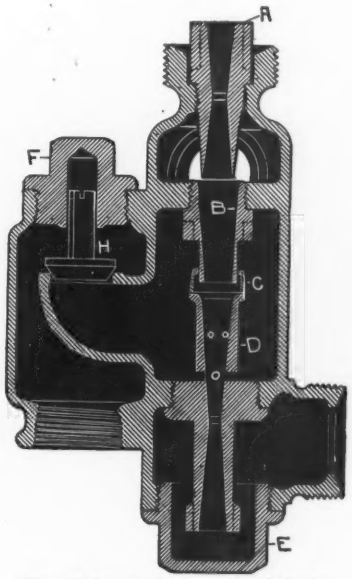


The Davidson Automatic Return Pump and Receiver

The pumps are fitted with bronze composition linings, valve seats and stems, piston rods of Tobin bronze, valve motion connections of forged steel hardened at wearing points. All workmanship and material are strictly first-class in every respect, and where conditions are fully stated the apparatus is warranted for the service to be performed. Further information may be obtained from M. T. Davidson Co., 154 Nassau St., New York.

The Chicago Automatic Injector.

Herewith is illustrated a sectional cut of the Chicago automatic injector, which was perfected and developed to meet the demands for an automatic injector which would successfully operate under the severe conditions now found in traction and stationary engineering. It is constructed upon an entirely new principle, which greatly increases its range of operation with both high temperatures of feed-water and high pressures of steam, at the same time doing away with that sensitiveness that is often found in machines of this class.



The Chicago Automatic Injector

In construction it consists of but three tubes, the body or shell, one check valve and a bushing. All of these parts are held to place by screw-threaded joints, and cannot drop out and become lost.

Owing to the extreme simplicity of its construction, the Chicago injector is easily cleaned and repaired. Both the steam jet and forcing tube may be removed by the use of an ordinary monkey-wrench, and when cleaning becomes necessary it may be accomplished without breaking any pipe joints or removing the injector from the boiler, and without the aid of special wrenches. Removing the bottom cap exposes the end of the forcing tube which may be removed with an ordinary wrench, allowing free access to the interior of the machine for cleaning.

The Ohio Injector Company, 2128 Main St., Wadsworth, Ohio, who manufacture the Chicago and a full line of injectors, ejectors, lubricators, steam specialties and oiling devices for all classes of service, guarantee it for the severe conditions now found in boiler feeding.

Lignite Fuel in Idaho.

Lignites occur at a number of places in Idaho, but only within the last two or three years have any of these beds been extensively mined. Mining has been done in the Horseshoe Bend and Jerusalem districts, occupying the lower portion of a ridge between the Boise and Payette Rivers; in a district near Salmon City, in Lincoln County; and in one at the eastern edge of the State, in Bingham and Fremont Counties, where the Sublette fields of Wyoming extends across the State line. The total production for the State in 1906 amounted to 5,365 short tons, having a spot value of $16,538.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Cassco Bar-metallic Packing is shown in a pamphlet issued by the manufacturers. This packing is made up in little bars or segments, which are easily slipped into the stuffing box around the rod, and when compressed with the gland makes a solid metallic packing, which it is claimed, will stand under any pressures. A copy of this pamphlet, and also a sample of the packing, if desired, will be sent to any one interested, by the Cassco Bar Metallic Packing Co., 140 Dearborn Street, Chicago, Ill.

The McKnight receiver and oil separator may be the means of saving you lots of trouble next winter if installed now in connection with your heating system, to receive the condensation from which it will separate the oil and give you back your water to use over again in the boilers, instead of sending both oil and water into the sewers. Descriptive circular will be mailed by the inventor and manufacturer, Walter J. McKnight, 179 Washington Street, Buffalo, N. Y.

"The Boston Journal" of August 3, published the exact reproduction of an advertisement of the American Steam Gauge and Valve Mfg. Co., just as it first appeared over 50 years ago, together with a brief review of the early history of this well-known house. It was this house that first obtained the rights to manufacture the Bourdon steam gauge in America, the first of which were made at No. 4 Charlestown Street, Boston. The present great house, which is the result of that small beginning, is located at 208 and 210 Camden Street, Boston, Mass., where hundreds of mechanics are constantly employed in the manufacture of their well-known "American" steam specialties, among which are the American Thompson Improved Indicator, with the new improved detent motion, which is a distinctive feature enabling the user to take cards at a rapid rate. The American Combined Pressure and Recording Gauge gives a daily chart showing the exact pressure of the steam carried on your boilers at every hour of the day or night. The American Special Pop Safety Valve and numerous other American specialties, each of which is described in special illustrated circulars.

Cynthiana, Ky., May 15, 1907.

Dear Sir:—Please find money for another year's subscription. Can't do without THE PRACTICAL ENGINEER. It's the best I know of. Success to it.—J. S. Johnston, Supt. Electric Light Co.

Minneapolis, Minn., Jan. 7, 1907.

Gentlemen:—Please excuse me for letting my subscription run out before renewing. I would not drop THE PRACTICAL ENGINEER for five times the price.—Mike O'Neil.

It never pays to buy cheap lubricating oils just because they happen to cost a few cents a gallon less than the best. Cheap oils are like all other cheap things. They may last just as long as the better kind, but the increase in the friction load will generally more than off-set the little saving in the oil bill. Any engineer who is interested in better lubricants should get the catalog issued by the A. W. Harris Oil Co., 320 South Water Street, Providence, R. I.

A large new catalog describing Liberty Boiler Tube Cleaners, The Liberty Oil Purifier, which uses no water in its method of purification, also the Twin Strainer for the illumination of rubbish, such as fish, sticks, leaves, etc., from the feed water where the supply comes from a creek or pond, has just been issued by The Liberty Mfg. Co., 6409 Susquehanna Street, Pittsburg, Pa.

Is the fusible plug in your boiler all right? If not, better get the Robinson Standard Plug from Chas. T. Luce, 160 Congress Street, Boston, Mass. It is easily applied and just as easily removed.

A free sample spool of Palmetto Packing will be sent to any engineer who wants to try it. Address, Green, Tweed & Co., 109 Duane Street, New York.

Pawnee, Ill., Aug. 5, 1907.

Gentlemen:—I am enclosing fifty cents in money order, for which send THE PRACTICAL ENGINEER for one year, beginning with the September number. A copy was sent to the Pawnee Electric Light Plant. I liked it so well I want it all the time.—Fred L. Andreson.

The Southern Hydraulic Engineering Co., with offices in Atlanta, Ga., and Birmingham, Ala., has been appointed agents for the products of the C. H. Wheeler Manufacturing Co., of Philadelphia. These consist of the Wheeler-Mullan High Vacuum Apparatus, the Wheeler-Pratt Water Cooling Towers, Wheeler-Barr Pumps, the C. H. Wheeler Feed-Water Heaters and the Mullan Suction Valveless Air Pumps. This latter pump is attracting considerable attention in the engineering field. It was first placed on the market about two years ago. Already there are over eighty installed, with fifty more in course of construction.

As the efficiency of the Parsons or Curtis Turbine is increased twenty per cent. when the vacuum in the condenser is raised from 26 to 28 inches, a number of "wet and dry" machines have been placed on the market to secure this result. These invariably consist of two separate pumps however, one for removing water and the other air. As a whole, these outfits are cumbersome, complicated, and, both as regards first cost and maintanance, expensive.

The Mullan Suction Valveless Air Pump performs the function of removing both air and water itself. As its name implies, there are no suction valves; in fact, it is so simple in construction that there is practically no chance for any thing to get out of order. A unique feature of this pump is the construction of the piston, which is composed entirely of brass. It is made wide and contains a number of annular grooves. The inventor figured that as the piston fitted very closely, the water accumulating in these grooves would form a film between the piston and cylinder, thereby preventing leakage and undue wear, and his expectations have been more than fulfilled. After two year's continuous service, the first pump showed no perceptible wear of piston or cylinder, due presumably to this water packing; so in order to further investigate the consequences, should the piston in any way become worn, it was removed and its diameter reduced on a lathe until it was 3/32" less than the cylinder diameter; with this apparent handicap the pump was again started and yet maintained a vacuum of 29 inches.

Catalog giving complete description of its workings may be had by addressing the manufacturers direct as above.

Engineers send your address and who employed by, and we will send one set of Corliss Valve Rod Packing free of charge, Express Prepaid. Give diameter of rod, gland, and depth of box. Also state if bottom of box is *bevel or square.* Ideal Metallic Packing has no equal for steam, air and ammonia. We have the documents to prove it. Address, IDEAL METALLIC PACKING CO., South Stillwater, Minn.

SALESMEN—We should like to arrange with a few men who are engaged in selling to steam users, to handle in conjunction with the line they now have, or with unemployed engineers, in territory where we are not represented, our fuel economy specialties. We offer attractive commissions to active and reliable men. Address, SARCO FUEL SAVING & ENGINEERING COMPANY, 140 Cedar Street, New York City.

WANTED—High-grade steam specialty salesmen who have the ability to sell the best economic appliances on the market direct to power plants. No objection to men handling non-competitive goods. Extremely attractive proposition. Goods well-known and of highest reputation. Address, Box 10, Care of The Practical Engineer.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address FRANCE PACKING Co., Tacony, Phila., Pa.

WANTED—Engineers and Mechanics to make big money selling O. K. Hand Soap. A 10-cent Can will instantly remove more dirt and stains from the hands than 4 cakes of any soap made, and it will not injure the most delicate skin. Small sample free. O. K. HAND SOAP CO., 570 Columbus Ave., Boston, Mass.

SLIDE RULES

F. F. NICKEL,
27 Winans Street, East Orange, N. J.
Send stamp for reference slip containing valuable formulas for steam engineers.

A gilt edge proposition for a few travelling and erecting engineers. Address, Box 24, South Stillwater, Minn.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

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Patents secured promptly and with special regard to the legal protection of the invention.
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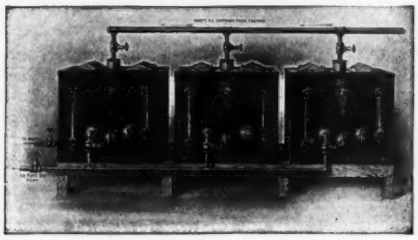
186 Dietz Bldg. WASHINGTON, D. C.

ANY MACHINIST desiring a good set of books on modern machine shop practice, should have the "Rogers Library", consisting of three volumes; price $7.00, payable $1.00 a month. Complete catalog on request.
WRITE TO-DAY
THEO. AUDEL & CO., Pub.
63 Fifth Ave. New York

The Burt "Unit" Filter



Can be used with or without an oiling system. This makes it possible to put in a "Unit" now, and later, if you so desire, add a complete system without extra expense. With a "Unit" you can increase your filtering capacity just as your needs dictate. No waste of either energy or oil. We are anxious for you to know the superior merits of this filter. To that end we will send it to you for

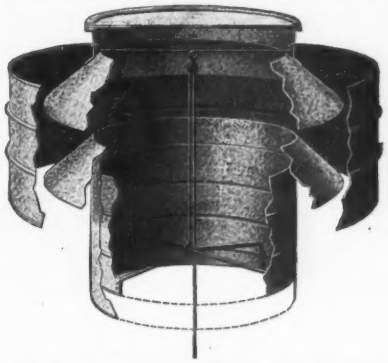
30 Days' Trial—Free.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Burt Ventilators



In the building of metropolitan sky-scrapers, where hundreds of thousands of dollars are represented, every item of construction is selected by experts with extreme care and consideration. The Illinois Athletic Club of Chicago, recently completed and one of the finest buildings in the west, is equipped with ten 30-inch Glass Top Burt Ventilators. These are the best ventilators for either large or small buildings—wherever good light and air are desired they cannot be equaled.

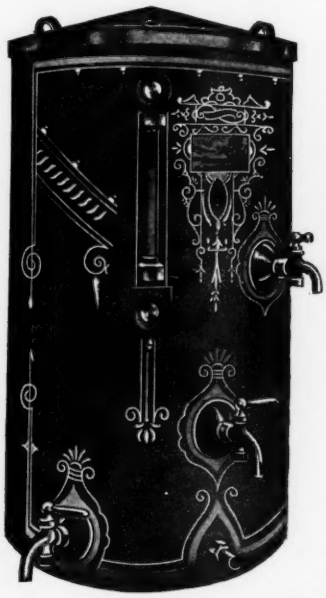
Ask for 80-page Catalogue.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

The "Cross" Oil Filter



Have you any money invested that pays from 50 to 90 per cent? Would you consider such an investment a money-maker? Most propositions that promise such dividends are unreliable, and you take a long chance if you put money into them. Not so with the

Cross
Oil
Filter

It will save from 50 to 90 per cent. of your oil, and we prove it before you pay a cent.

Try it 30 days at Our Expense.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

The Burt Exhaust Head

Ever get out under one of those spitting, sputtering exhaust pipes with a new spring suit on? Did it have a christianizing influence on you? May be it was your own steam pipe? In that case your neighbors would probably approve of the punishment you received. The BURT Exhaust Head is not that kind. It is built so that it is impossible for anything but dry steam to escape. Try it for 30 days. If you are not satisfied—

The Trial Costs You Nothing—Not a Cent.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Hosmer Furnie, B. C., Jan. 24, 1907.

Dear Sir:—I have just received notice from you that my subscription is about to expire; enclosed you will find fifty cents to renew it for one year commencing with February number. I would not be without it for four times the price. Through it and the studies its perusal led to, I climbed from an engineer's position to that of Master Mechanic, for a coal mining company. I can thank your paper for starting me in the right direction and pushing me along afterwards. I remain, your faithful friend, Bert Swanton.

What is Oxoilox? Users of belts should be acquainted with that term, as it is literally a proposition of "From the Ox to the Ox." It puts life and strength in the leather from which the belt is made, which in turn is made from the hide of the ox. Oxoilox is made from the finest hoofs of cattle obtainable, the oil from which is refined and treated by a special process. It is, therefore, only natural that this oil will restore the belt to nature, and as a belt dressing and preservative, it has had extensive use. A circular, together with a sample of Oxoilox, will be sent to any engineer interested. Address the F. S. Walton Co., 421 Walnut Street, Philadelphia, Pa.

The liberal free offerings of courses in the International Correspondence Schools, by the Cancos Manufacturing Co., 146 N. Second Street, Philadelphia, has created considerable interest among engineers as to just how they can obtain these advantages. Other useful articles for the engine room are also given away by this firm, who will be pleased to send any engineer interested, the full particulars.

The Keystone Chemical Co., of Philadelphia, by means of their Pressure Filter System, not only remove the suspended impurities in the feed-water, but also the dissolved scale-forming impurities, so that the feed-water entering the boiler will not cause the boiler to prime, scale or corrode. This is a big claim, but the company is making good in various plants throughout the country. Write to them for their catalog which explains the Keystone Pressure Filter System in detail.

Chicago, Ill., Jan. 10, 1907.

Gentlemen:—Please find enclosure for renewal. We always look forward for the arrival of THE PRACTICAL ENGINEER, for it cannot be beat for straight goods.—E. A. Gingrich, Engr., Chicago and Northwestern Ry. Co.

"Kinks and Receipts" is a book of useful information for engineers, which the Geo. W. Lord Company, of Philadelphia, are sending free to engineers who send them a sample of scale from the boilers in their charge for analysis.

The Nason Manufacturing Company, 71 Fulton Street, New York, have a steam trap catalog, which may help any one having steam trap troubles. They will send you one

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Wright safety water columns are equipped with a whistle, which shrieks when the water level approaches the danger point. It is fully described in the Wright catalog issued by the Wright Manufacturing Company, 72 Woodbridge Street, Detroit, Mich.

A new catalog containing 232 pages, descriptive of all that is best in fine mechanical tools and containing over 300 illustrations has been published by The L. S. Starrett Company, Athol, Mass. Many new and unique tools are shown; some additions to size of former tools have been made and several more pages of useful tables are given. Every tool has been indexed by both name and number, and no pains have been spared to make this the most complete tool catalog ever issued. Mechanics and supply dealers are invited to send for a copy.

A sample bar of Stephenson Belt Dressing will be sent to any engineer or superintendent wishing to give it a trial. The Red Label is for leather and the Green Label for rubber or canvas belts. State which you want when writing. Address Stephenson Mfg. Co., Albany, N. Y.

The Trill Indicator Company, Corry, Pa., reports an exceptionally heavy July and August business, the orders for their instruments equalling the very satisfactory business which they experienced during the winter and spring, and they are increasing their force in order to be able to ship promptly. They have an attractive indicator catalog, which they want to send engineers who writes for it.

The Leyland Automatic Lubricator gives an automatic and controllable feed of lubricant to the steam cylinder. It feeds just a little oil each time the valve opens and stops feeding when the valve closes. It is so constructed that the steam is brought into direct contact with the lubricant, which enables it to handle the heaviest oils, or greases, as easily as light oils. It is simple in construction and inexpensive. A circular describing it will be mailed if requested of the Empire State Engineering Co., 149 Broadway, New York.

The manufacturers of Lubron Grease advise us that some recent tests have shown that Lubron would stand a much higher temperature than any other grease against which it has yet been tested. A sample can of Lubron will be sent free to any one wishing to give it a trial. Address Knowlton Packing Co., Chapel Street, Newton, Mass.

Cope's Automatic Boiler Feed Regulator is described at considerable length in a booklet just received from the makers of this interesting apparatus. The Copes Regulator is operated automatically by an expansion tube, the action of which depends upon the height of water in the boiler.

The Copes Pump Governor is also described. A copy of this booklet and full information in regard to their free trial offer will be mailed upon request by the American Boiler Economy Co., Mutual Life Building, Phila-

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Just what can happen when a steam main bursts or a fitting on the line breaks, or one boiler of a battery gives way, is vividly told in a newly issued pamphlet describing the Lagonda Automatic Boiler Cut-off Valve. The pamphlet also explains the dangers from ammonia explosions and the way in which the Cut-off Valve may be used to stop the flow before enough of the ammonia gets out to do any harm. A number of interesting tests are given to show the certainty with which this type of automatic valve does the work in case of accident. The valve is illustrated in detail and its action explained. This pamphlet may be had free, by writing to the Lagonda Mfg. Co., Springfield, Ohio.

Following is copy of a letter which the Buckeye Boiler Skimmer Co., Colburn Avenue, Toledo, Ohio, received under date of July 25, 1907, from Monterey Coal Co., of West Monterey, Pa.

Gentlemen:—Please enter our order for another one of your BUCKEYE FLOATING SKIMMERS, to be a duplicate of the last one. We installed two of your skimmers last September, and think a boiler not complete without one of them.—A. J. Watson, Gen'l Supt.

One of the most complete and modern lines of brass and iron specialties is shown in the catalog of The Wm. Powell Co., of Cincinnati, which has been mailed to their customers. This catalog presents their line in a most complete and practical manner, giving dimensions of every article for which a dimension may be required, and explaining in detail the merits of their well-known specialties. A valuable series of tables and rules is bound in with the catalog, giving in a concise form information that every engineer and shop manager requires in his daily practice. A copy is yours for the asking.

The Patterson-Allen Engineering Co., 421 Chestnut Street, Philadelphia, have published a booklet devoted exclusively to a description of the "Everlasting blow-off valve—a new one, which seems to deserve its name. They will mail a copy to any engineer or power plant owner upon request.

The Ohio Blower Co., 43-47 Michigan Street, Cleveland, Ohio, have a booklet devoted to the Swartwout Cast Iron Exhaust Head which they will mail upon request.

St. Paul, Minn., Feb. 11, 1907.

Gentlemen:—Please find fifty cents for a renewal for one year to THE PRACTICAL ENGINEER. I could not get along without it, if it cost a dollar a year. It's indeed a practical paper.—Christian Parson.

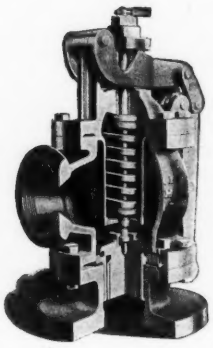
Torres Sonora, Mexico.

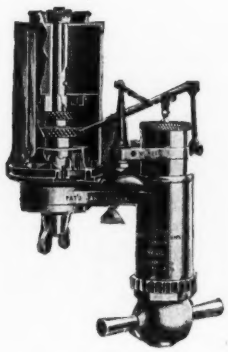
Gents:—Your circular of July 2d just received. Mail in Mexico arrives slow. I have had four mail carriers killed by the Indians during the past ten months. Would like your magazine just the same. Enclosed find payment for same.—S. Ben. Smith, Supt.

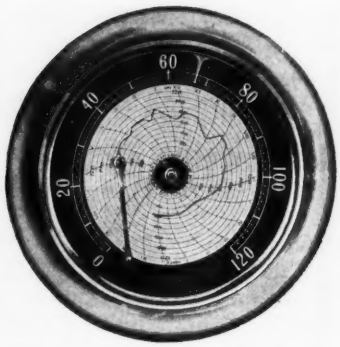
A fine new catalog of mechanical rubber goods, showing a complete line of packings for every kind of service, hose belting, pump valves and numerous other articles of interest to power plant operators has just been issued by Osgood Sayen, 421 Arcade Bldg., Philadelphia. Write for yours while they are fresh.

A thoroughly practical book of information on the causes, effects and prevention of boiler scale, grease and corrosion, in which the facts are not clouded with elaborate chemical formula, but clearly and concisely set forth in understandable English, has just been published by the Bird-Archer Co., 90 West Street, New York City. They will send a copy if you mention THE PRACTICAL ENGINEER.

The Ideal Metallic Packing Co. have doubled their factory capacity since moving to South Stillwater, Minn.







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Three hundred 16-candle power—100 to 120-volt "Boston" guaranteed incandescent lamps for $36.00, and the freight paid, if east of Mississippi River, looks good to us. Briefly, that's the proposition offered by the Boston Incandescent Lamp Co., Danvers, Mass.

When special castings are required for the boiler room or furnace, especially boiler fronts, special grate bars, etc., it is often difficult to find the right place to get them. The Kutztown Foundry & Machine Co., 116 N. Broad Street, Philadelphia, are prepared to do all kinds of special casting work for the furnace or boiler room.

East Boston, Mass., Jan. 8, 1907.

Gentlemen:—I am in receipt of yours of January 5th, informing me that my subscription has about run out, and I take pleasure in having it renewed. It has been of great benefit to me in the past year, and I should feel lost without it, as it is a paper that contains the facts as they are.—D. F. Crowther.

Cookson Improved Feed Water Heaters are interestingly shown in a handsome new catalog published by Bates Machine Co., Joliet, Ill., and many excellent illustrations show the construction, operation and manner of connecting up the heater for services. The large half-tone illustration, on page 8 of the catalog, illustrates the distribution of the water after entering the heater better than any similar cut that has come to our notice. This catalog will prove very useful to any engineer or steam user contemplating the purchase of a new heater.
Mass.

The Stillman-Carmichael Improved Damper Regulator can be used for regulating the draft in connection with steam boilers, or, for regulating stokers, blowers and pumping engines, paper drying machines, elevator pumps, pressure valves and other purposes, which are explained in the catalog of the Stillman-Carmichael Co., 18 Pearl Street, Boston, Mass.

How and where to use Metal Hose in power plants is told in the catalog of Pennsylvania Metallic Tubing Co., 1306 Arch Street, Philadelphia, Pa.

The thermometer is now a necessary requisite in the power plant, and engineers should investigate the merits of the Standard Dial Thermometer. This thermometer has a dial which is easily read in the darkest boiler rooms, and is much more durable and accurate than the mercury column instruments. The Parker Manufacturing Co., 8 Clifton Street, Boston, Mass., are the manufacturers, and will be pleased to send their circular fully describing it to all inquirers.

"Steam Engine Indicators and Their Attachments" is the title of an attractive catalog issued by James L. Robertson and Sons, 40 Warren Street, New York. It illustrates and describes in detail the well-known Improved Robertson-Thompson Indicator and Victor Reducing Wheel and other attachments. A copy will be mailed free to any engineer upon request.

The Watson and McDaniel Co. have issued a catalog illustrating and describing the McDaniel Steam Traps, Watson Reducing Valves and other steam specialties manufactured by them. A copy will be mailed free to those sending their name and address to Watson and McDaniel Co., 147 N. Seventh Street, Philadelphia, Pa.

Engineers who have experienced scalds or burns while trying to shut off a water gauge, when the glass breaks, should write to the Paul B. Huyette Co., Inc., 1245 Betz Building, Philadelphia, Pa., for their circular describing the "P. B. H." quick closing Water Gauge.

Cheshire, Mass., Feb. 6, 1907.

Gentlemen:—Enclosed find order for fifty cents for paper for another year. I don't think I could get along without THE PRACTICAL ENGINEER. It is the best paper of its kind I ever had anything to do with. Thanking you for past favors, I remain as ever yours, W. H. Raymond.

Wonder how many readers of THE PRACTICAL ENGINEER have had trouble with leaky gauge cocks at some time in their experience as engineers. A leaky gauge cock is one of those provoking little nuisances which tries the temper and soon wastes enough steam to buy a new one. It is, therefore, a matter of considerable satisfaction to learn of a gauge cock which, it is claimed, never leaks. The "P. B. H." gauge cock has been in general use for several years. Many thousands of them have been sold, and not a single one has ever been reported to the makers as leaking, which is a remarkable record. The Paul B. Huyette Co., 1245 Betz Building, Philadelphia, who manufacture these gauge cocks offer to send one free for trial to any steam user.

A packing catalog showing a most complete line of sheet and rod packings for steam, water, air and every packing requirement, also a memorandum book, both of which will be very much appreciated by engineers, will be mailed to any engineer upon request by The Revere Rubber Co., 77 Bedford Street, Boston, Mass.

A water gauge in which the water shows black is a novelty, but in practice has been found to be a practical innovation, and is meeting with the success that practical things deserve. It is described in detail, together with the "Wiltbonco" water column outfit, and other specialties in a catalog issued by the Jerguson Mfg. Co., 223 Columbus Avenue, Boston, Mass.

There are not many steam plants now-a-days but that are equipped with one or more force feed lubricators, and it is noticeable that in most all of the modern up-to-date plants the "Rochester" Force Feed Lubricator is very much in evidence. Engineers, generally, speak highly of this lubricator, many claiming that it has paid for itself within a month after it is installed. It seems reasonable that this style of lubrication should be economical, especially for boiler feed and elevator pumps, both of which are extravagant in the use of oil when not equipped with the best methods of lubrication. The Rochester Lubricator is manufactured by Greene Tweed Co., 109 Duane Street, New York City. They have a fine catalog describing the lubricator fully, and showing the manner of application to various makes of engines, pumps and other machinery. They will be glad to send one to any engineer interested in the subject of better lubrication.

Waltham, Mass., Feb. 6, 1907.

Dear Sir:—Please find enclosed money for one year's subscription commencing with March. I think it the best paper in the world for the money.—J. C. Muzzey, Sect'y, No. 16 N. A. S. E.

The Cherry Chemical Co., manufacturers of Red Seal Boiler Compound, No. 10 N. Nineteenth Street, Philadelphia, in this issue calls the attention to the fact of this month being their fourteenth anniversary. For the greater part of that time they have been constant and regular advertisers in THE PRACTICAL ENGINEER, small at first, but now large advertisers, which fact indicates that our readers have found them to be competent and reliable. For several years past they have made a specialty of analyzing sample of boiler scale of feed water, and then preparing a special compound for each particular case, which fact has, no doubt, contributed largely to their fourteen years of success.

The General Specialty Co., of Buffalo, N. Y., have recently installed some special apparatus for the testing of their "DEMON" and "TORPEDO" cleaners before being sent out on their orders. The "DEMON" machines must undergo a brake test and develop the required pulling power before passing final inspection. This is something on the order of the brake tests given by the engine manufacturers to ascertain if their product develop the required horse power. The "TORPEDO" cleaners must pass a different kind of a test, but equally interesting.

Engineers who intend visiting Buffalo, either at the convention of the N. A. S. E., at Niagara Falls or any other time, are cordially invited by the above company to visit their factory. Their address is 893 Niagara Street.

A new hose coupling, composed of only three parts, with no gaskets or packing, and which will stand the roughest kind of usuage and still remain air or steam tight, is described in a new circular issued by the Thos. Dallett Co., Twenty-third and York Streets, Phliadelphia.

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